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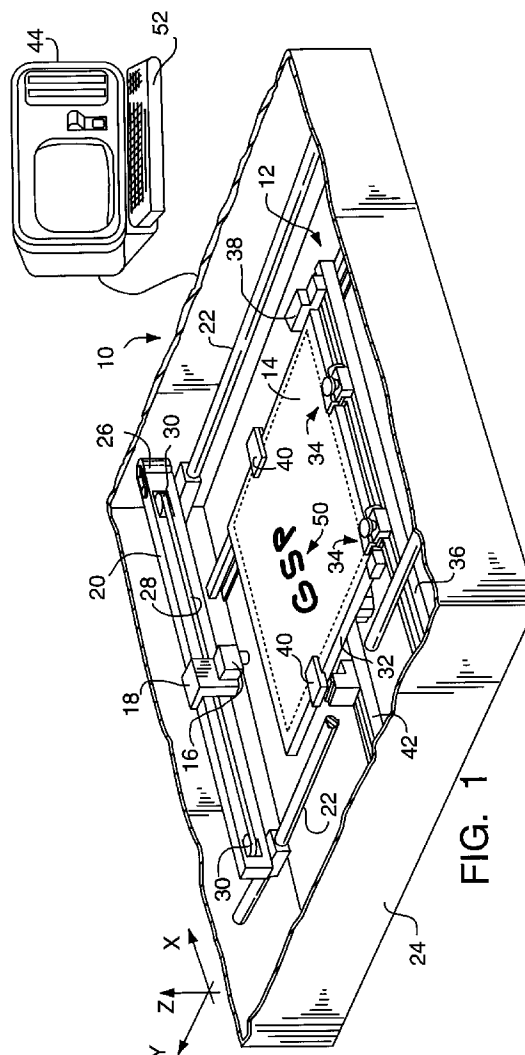
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(54) **Method and apparatus for printing graphics directly on fabrics.**

(57) The present invention provides a method, apparatus and fixative compositions for printing graphics directly on fabric. According to the invention, fixative is applied to only that area of the fabric (14) covered by the graphic (50). Thus, the problems associated with applying fixative to the entire surface of the fabric (14) are eliminated. The invention further provides an apparatus (10) for precisely and automatically positioning the graphic (50) with respect to the fabric (14) and for applying the fixative to only that area of the fabric (14) corresponding to the graphic (50). Fixative compositions useful in practicing the invention are also provided.



BACKGROUND OF THE INVENTION

The present invention relates to printing graphics directly on fabric. More particularly, the invention provides a method, apparatus and fixative compositions for printing graphics directly on fabric using ink-jet printing technology.

In the past it has been common practice to print graphics on fabric by means of a screen printing process. In such a process, the fabric is placed in a printing press which includes a printing screen having a pattern of open and closed pores defining the graphic to be printed. The graphic is printed by placing the screen over the fabric and forcing ink through the open pores by means of a roller or squeegee.

The screen printing process as typically practiced by those skilled in the art is time consuming, labor intensive and expensive. First, the graphic to be printed must be formed on the screen, usually as a positive, by photographically locating the graphic on a transparent sheet. The screen is then coated with a photographic emulsion, and the transparent sheet bearing the graphic is placed over the emulsion. The areas of the emulsion not covered by the graphic are then hardened by exposing the emulsion to light directed through the transparent sheet. Exposing the photographic emulsion in this manner permanently closes the pores in the portion of the screen covered by the hardened emulsion. The unexposed areas of the emulsion are subsequently washed off of the screen to provide an area of open pores which, in conjunction with an adjoining area of closed pores, define the graphic to be printed.

Each time a new graphic is to be printed, a new screen bearing the desired artwork must be prepared. Moreover, prior to printing, the graphic must be precisely located with respect to both the printing screen and the printing press to insure that the printed graphic is properly positioned on the fabric. The time, labor and expense of preparing the printing screen and properly positioning the graphic is particularly critical when printing a multi-color graphic on fabric. In such a case, a number of printing screens, one for each color, must be prepared, and great care must be taken to insure that the print of each individual color applied to the fabric precisely registers with the prints of all the other colors comprising the graphic.

U.S. Patent No. 5,156,089, assigned to the same assignee as is the present application, discloses a method and apparatus for preparing a printing screen using printing technology. According to this reference, a screen having a photographic emulsion applied to one surface thereof is supported in a printing mechanism capable of movement along X, Y and Z printing axes. The screen is oriented with respect to the printing axes, and a selected location on the screen is aligned with a selected coordinate position on the printing axes.

The printing mechanism is provided with data defining the graphic to be printed directly on the emulsion layer, data defining the dimensions of the screen, and data defining selected coordinates within the dimensions of the screen with which corresponding reference coordinates of the graphic are to register when the graphic is printed on the emulsion layer. A graphic is printed directly on the emulsion layer according to the data provided, and after the printing operation is complete, the emulsion layer is exposed using the printed graphic as an exposure mask. The screen is then washed to remove the unexposed portions of the emulsion together with the printed graphic to leave a pattern of open and closed pores on the screen defining the graphic.

The method and apparatus disclosed by this patent permit the graphic to be precisely and automatically located with respect to the printing screen. While this significantly reduces the time and effort required to properly align the screen in the printing press, it does not eliminate the need to first prepare a printing screen, mount the screen in the printing press and then force ink through the open pores of the screen to print the graphic on fabric.

U.S. Patent No. 4,702,742, discloses a method of printing on fabric using an ink jet process. According to this reference, the fabric is pretreated, prior to printing, with a chemical acceptor which will bond or "fix" the dye deposited on the fabric. The acceptor is applied by, for example, dipping, spraying, roll coating, rod-bar coating or air knife coating the fabric with an aqueous mixture containing the acceptor. After the acceptor has been applied and allowed to dry, the fabric is printed.

Those skilled in the art recognize that pretreating the fabric with an acceptor or fixative is required in virtually all methods of fabric printing, whether an ink jet process or a more conventional screen printing process is employed. Pretreatment is necessary to catalyze the covalent bonding of the dye to the fibers comprising the fabric. This results not only in a sharper, clearer graphic, but also a washfast graphic that will exhibit good print density and will not stain unprinted areas of the fabric, even after repeated washings.

Unfortunately, because the typical practice is to treat the entire fabric and not just the area to which the graphic is applied, there is the chance for dye fixation outside the print area. Pretreating the entire fabric also requires an excess of fixative which results in wasted chemicals, as well as increased chemical disposal and recycling expenses. In the case where a multi-colored graphic is to be printed, the entire fabric must be pretreated with fixative prior to the printing of each individual color, a procedure which is particularly time consuming. Finally, pretreating the entire fabric with fixative requires expensive and time consuming post treat-

ment procedures such as, for example, steaming the printed fabric, soaping the fabric at boiling temperatures or wrapping and storing the printed fabric for a twenty-four hour period.

British patent application GB 2 252 335 discloses a method of printing a graphic on fabric with an ink jet printer, wherein the fabric is pretreated with fixative by means of screen, roller or ink jet printing. It appears that such pretreatments are applied to the entire fabric and not just the print area. More importantly, the reference clearly teaches that applying fixative with an ink jet printer is appropriate where only a superficial print is required. Where a deeply penetrated print or a deep shade is required, this reference states that a more typical pretreatment method, such as padding, must be employed.

Japanese patent application No. 60134085 also discloses a method of ink jet printing on fabric. According to this reference, the fabric is pretreated by spraying fixative over the entire surface of the fabric using an ink jet printer. Thus, this reference does not avoid the disadvantages associated with prior art methods of applying fixative.

It is therefore an object of the present invention to provide a method for printing on fabric which attempts to avoid the disadvantages associated with prior art pretreatment procedures; and/or to provide fixative compositions which can be employed in such a method; and/or to provide an apparatus for carrying out such a method for printing on fabric.

SUMMARY OF THE INVENTION

The present invention meets these and other objects, according to one aspect of the invention, by providing a method for printing a graphic directly on fabric. The method includes the steps of providing a printing mechanism comprising printing means and a support means moveable relative to one another, and supporting the fabric on the support means with the fabric oriented with respect to X, Y and Z printing axes. The fabric is also supported such that a selected location on the fabric is aligned with a selected coordinate position on the X, Y and Z axes. The method further includes the steps of providing the printing mechanism with data defining a graphic to be printed on the fabric, and moving the printing means and the support means relative to one another to print the graphic on a print area of the fabric according to the data provided.

According to the invention, fixative is also deposited on the fabric according to the data defining the graphic. Thus, fixative is applied only to that area of the fabric on which the graphic is printed. Fixative is deposited either before or after printing the graphic, and, in some applications, the fixative is deposited on the fabric both before and after the graphic is printed. Since the fixative is applied only to the print area, fixative chemicals are not wasted, and the problems of disposal and recycling of such chemicals is greatly reduced. Further, the risk that dye will be fixed to areas of the fabric beyond the print area is eliminated. Finally, since the fixative is applied to the print area exclusively, there is no need for long dwell times between successive applications of fixative and dye, nor is there a need for expensive and time consuming post treatments of the printed fabric.

The method may be employed for a wide variety of fabrics, including cotton fabric, cotton/synthetic blends, silk, wool, rayon, polyester and polyester blends. The method produces a sharp, clear, wash-fast graphic which exhibits uniform print density and superior edge quality, even after repeated washings in hot water and detergent.

According to a second aspect of the invention, fixative compositions useful in practicing the disclosed method are provided. In the case where the fabric is printed with a reactive dye, the fixative composition comprises an aqueous solution of an alkali metal/weak acid salt. The composition may further include an alkali hydroxide, a humectant, a chelating agent and an organic solvent. Where the fabric is printed with a pigment/resin binder dye, the fixative composition comprises an aqueous solution of an alkali metal/halide salt. Again, the composition may include additives such as a humectant, a chelating agent and an organic solvent.

Another aspect of the invention relates to an apparatus for printing a graphic directly on fabric. The apparatus includes means for inputting, storing and processing data defining the graphic to be printed, means defining a support surface for supporting the fabric, and printing means for printing the graphic on the fabric. The printing means and the support surface are movable relative to one another. The apparatus further includes means for applying fixative on the fabric, and the means for applying fixative and the support surface are also moveable relative to one another. Control means are provided for activating the printing means and for moving it and the support surface relative to each other according to the data to print the graphic on the fabric. The control means also activates the means for applying fixative and causes it and the support surface to move relative to one another according to the data to apply fixative to the fabric precisely in the area corresponding to the graphic.

While any printing mechanism which can print the graphic and apply fixative to the print area according to the data provided is within the scope of the invention, in the preferred embodiment the apparatus is an ink jet printer. The printing mechanism may include a single print head or cartridge having associated interchange-

able reservoirs containing either a dye solution or a fixative solution. Alternatively, the printing mechanism may include two or more interchangeable print heads each having associated reservoirs filled with either a dye or fixative composition.

5 BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a partially schematic perspective view of an apparatus constructed according to the invention.

Figure 2 is a block diagram of the control computer which forms a part of the apparatus illustrated in Figure 1.

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DETAILED DESCRIPTION OF THE INVENTION

Figure 1 illustrates an apparatus made according to the invention for printing a graphic directly on fabric. The method for printing the graphic and the fixative compositions used to fix the dye to the fabric will be described in conjunction with the description of the apparatus.

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The printing apparatus, generally designated 10, includes a support assembly 12 for supporting a sheet of fabric 14 positioned with respect to the illustrated X, Y and Z printing axes. An ink jet printing head 16 is mounted above the support assembly 12 on a pen carriage 18 for movement along the X and Y printing axes. The pen carriage is slidably mounted on a printing carriage 20 which extends across the apparatus 10 in the direction of the X printing axis. The rail 20 is itself slidably mounted at each end for movement in the direction of the Y printing axis on guide rails 22, 22 which are carried by the frame 24 of the apparatus 10. An X direction drive motor 26 is driveably connected to the pen carriage 18 by means of a drive belt 28 and pulleys 30, 30 to move the carriage along the X-printing axis while, in the same manner, a Y direction drive motor 31 (see Figure 2), drive belt and pulleys (not shown) move the guide rail 20 along the Y-printing axis.

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Referring again to the support assembly 12, the construction of the assembly and the manner in which work material, in this case the fabric 14, is positioned with respect to the X, Y and Z printing axes is fully described in U.S. Patent No. 5,189,951, entitled PLANAR SUPPORT FOR MATERIAL MOUNTED TO A FRAME AND METHOD OF USE. Accordingly, the disclosure of this patent is incorporated herein by reference.

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Briefly, however, the assembly 12 includes a support frame 32 to which the fabric 14 is affixed. The fabric is affixed to the frame by releasable adhesive; however, any other suitable means for releasably securing the fabric to the frame without damage may be employed. After the fabric is affixed to the frame, the frame is properly positioned with respect to the X and Y-printing axes in the apparatus 10, and a selected location on the fabric is aligned with the home position of the print head 16. Positioning of the frame is accomplished by means of X-coordinate clamping assemblies 34, 34, which are slidably mounted on guide bar 36, locating block 38, and Y-coordinate clamping assemblies 40, 40, which are slidably mounted on guide bar 42. As U.S. Patent No. 5,189,951 also fully discloses, the assembly 12 further includes means for positioning support frame 32 with respect to the Z-printing axis so that the fabric 14 is both located the optimum print distance from the print head 16 and oriented in a plane perpendicular to the Z-printing axis.

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The apparatus 10 further comprises control computer 44 which includes Random Access Memory (RAM) 46 for receiving and storing data 48 which defines a particular graphic, such as the graphic 50, to be printed on the fabric. The data 48 also includes data defining the dimensions of the fabric, and data defining selected coordinates within the dimensions of the fabric with which corresponding reference coordinates of the graphic are to register when the graphic 50 is printed. The control computer 44 also includes a control panel 52 through which a user may interact with the computer.

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The data input in the control computer may be produced on an associated graphics generating device (not shown) such as, for example, a scanner, CAD system or other computer-based graphics generating device. Such devices are well known to those skilled in the art and will not be discussed further, except to state that in the most preferred embodiment of the invention the graphics generating device includes all of the standard graphics editing and scaling functions. The graphics generating device may be an "on line" system communicating directly with the control computer 44, or it may be a stand alone system in which case the data 48 produced on the system is stored, for example, on a magnetic disc. In the latter case, the apparatus 10 further includes a memory storage device (not shown) for receiving and storing the data produced on the graphics generating device and for communicating that data to the computer 44. Regardless of how the data 48 are created and input to the computer, the data stored in the RAM 46 are processed by a print controller 54 and converted into print commands. Once the fabric 14 has been affixed to the frame 24 and properly oriented with respect to the X, Y and Z printing axes by means of the support assembly 12, the print commands are transmitted by the print controller 54 to print head 16 and the X and Y drive motors 26 and 31. The print head is activated and the drive motors move the pen carriage 18 and the printing carriage 20 relative to the support

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assembly 12 in response to the print commands generated and transmitted by the control computer in accordance with the data. In this manner, the print head 16 is translated over the entire surface of the fabric to print the graphic 50 directly on the fabric and to precisely and automatically position the graphic with respect to the fabric.

5 As noted previously, in the illustrated embodiment of the invention, the print head 16 is a ink jet head. While the print head may be of either the dot on demand or continuous type, such as a thermal, piezo or deflection head, in the preferred embodiment of the invention the print head is a bubble jet head available from Hewlett Packard under the commercial designation HP P/N 51626A.

10 To utilize the ink jet print head for the purposes of the invention, the original printing ink supplied by the manufacturer is removed from the print head ink reservoir, and the reservoir is then re-filled with the appropriate dye for the particular fabric being printed. For example, in the case where the fabric 14 is cotton, a cotton/polyester blend or rayon, reactive dyes or pigment/resin binder dyes have been found to be suitable. With respect to reactive dyes, high energy reactive dyes have been found to provide excellent performance; however, other reactive dye types may also be employed with good results such as, for example, low energy and
15 medium energy reactive dyes, as well as bifunctional, vinyl sulfone, dichlorotriazine, dichloroquinoxaline, monochlorotriazine, chloropyrimidine, acryloamino and N-methylol reactive dyes. Where the fabric being printed is a synthetic or a synthetic/natural fiber blend, other dye types such as disperse dyes or combinations of reactive disperse dyes have been found to be more appropriate. All of the dye types referred to above are well-known to those skilled in the art and, accordingly, do not require further description here.

20 To prevent scan lines during the printing operation and to provide exceptional edge quality and uniform dye density, the preferred method of printing the graphic is the overlap printing method described in U.S. Patent No. 5,247,317. In particular, the graphic is printed with a twenty-five line overlap. That is, on each successive pass of the print head 16 across the fabric 14, the immediately preceding 25 lines of printed pixel locations are reprinted. It should be understood, however, that the invention is in no way limited by the overlap printing
25 method employed in the preferred embodiment and that other printing methods typically practiced by those skilled in the art of ink jet printing may be used.

In the case of a multi-colored graphic, each color comprising the graphic is preferably printed sequentially. This is accomplished by means of a series of interchangeable dye reservoirs, each of which contains a different color dye. After a first color comprising the graphic has been printed, the reservoir containing that color dye
30 is removed from the print head 16, and a reservoir containing the second color dye to be printed is mounted thereon. The print head is activated and the second color dye is applied to the appropriate area of the fabric. This procedure is repeated until all of the colors comprising the graphic have been deposited on their respective print areas. Alternatively, the print head 16 may be of a design conventional in the art wherein a plurality of reservoirs are mounted on the print head so that multiple colors can be printed simultaneously.

35 Regardless of how the colors comprising the graphic are printed, covalent bonding between the dye and the fabric is facilitated by applying a fixative composition to the print area. Fixative is deposited on the print area in the same manner as described above in connection with the printing of the graphic. A reservoir containing the fixative composition is mounted on the print head 16, and print commands are generated and transmitted by the print controller 54 in accordance with the data defining the graphic to activate the print head 16
40 and the X and Y drive motors 26 and 31. Thus, the pen carriage 18 and the printing carriage 20 are moved relative to the support assembly 12 to translate the print head over the entire surface of the fabric and to deposit fixative on precisely that area of the fabric which corresponds to the graphic 50.

In the preferred embodiment, the fixative is applied to the entire print area corresponding to the graphic in a single application, regardless of whether the graphic is a multi-color graphic or a graphic comprising only
45 a single color. Alternatively, in the case of a multi-colored graphic, the fixative may be sequentially deposited on the print area which corresponds to the particular color being printed.

The fixative may be applied either before or after the dye is deposited on the fabric, and in some applications the fixative composition is applied both before and after the dye is deposited. There is no dwell time between the application of the fixative and the dye. Thus, the graphic is printed either immediately before or after
50 the fixative composition has been deposited.

The formulation of the fixative composition depends on the type of dye being deposited. Where a reactive dye is used, the fixative composition is an aqueous solution including at least one alkali metal/weak acid salt. Generally, the alkali metal/weak acid salt is present in the fixative composition at a concentration ranging from about 0.05M to about 1.0M, and sodium or potassium weak acid salts such as, for example, K_2CO_3 and Na_2CO_3
55 are preferred.

To enhance the covalent bonding of the dye to the fabric promoted by the fixative composition, the composition preferably includes an alkali hydroxide such as, for example NaOH or KOH. The alkali hydroxide makes additional binding sites on the fibers comprising the fabric available to the dye. Thus, the dye more deeply pen-

etrates the fabric and increased print density results. Generally, the hydroxide is present in an amount ranging from about 0.05M to about 1.0M.

The fixative composition also preferably includes a humectant and a chelating agent. The humectant draws water to the surface of the fibers which prolongs the fixing reaction. This results in a stronger bond between the dye and the fabric and higher print densities. The humectant is present in a concentration range of from 0 to about 3M. The chelating agent attracts any contaminating ions that may be present in the fixative composition and is present in an amount ranging from 0 to about 5g/l of the composition. In the most preferred embodiment of the composition, the humectant is urea, and the chelating agent is EDTA. However, the invention is in no way limited in this regard and any suitable humectant and chelating agent typically employed by those skilled in the art may be used.

To facilitate the use of an ink jet print head for applying the fixative composition, the composition also preferably includes up to about 20% by volume of an organic solvent. The solvent must have a boiling point above 110°C, and an aliphatic alcohol or glycol are the preferred solvents. The use of such a solvent also prolongs the drying time of the composition which results in a higher percentage of dye being bonded to the fabric. Again, while the solvents described above are the preferred solvents, any suitable organic solvent known to those skilled in the art may be employed.

In the case where the dye is of the pigment/resin binder type, the fixative composition comprises an aqueous solution of an alkali metal/halide salt. In the preferred embodiment of the invention the salt is CaCl_2 , present at a concentration of about 0.2M. Here, again, the composition may also include additives such as a humectant, a chelating agent and an organic solvent. These components are present in the same concentrations as set forth above, with urea as the preferred humectant, EDTA the preferred chelating agent, and an aliphatic alcohol or glycol being the preferred solvents.

Specific formulations for fixative compositions which have been found to be suitable are set forth in Table I.

Table I:

Reactive dye fixative formulations:

0.2M K_2CO_3 , 0.2M KOH, 1.9M urea, 1g/l EDTA, balance deionized water

0.2M K_2CO_3 , 0.4M KOH, 1.9M urea, 1g/l EDTA, balance deionized water

0.4M K₂CO₃, 0.4M KOH, 1.9M urea, 2g/l EDTA, balance deionized water

0.2M K₂CO₃, 0.2M KOH, 1.9M urea, balance deionized water

0.05M K₂CO₃, K₂B₄O₇, 0.05M KOH, balance deionized water

0.2M Na₂CO₃, 1.9M urea, balance deionized water

0.2M Na₂CO₃, 0.2M NaOH, 1.9M urea, balance deionized water

0.2M Na₂CO₃, 0.2M NaOH, 1.9M urea, 1g/l EDTA balance deionized water

90% (0.2M Na₂CO₃, 0.2M NaOH, 1.9M urea, 1g/l EDTA balance deionized water), 10% amyl alcohol

Pigment/resin binder dye fixative compositions;

0.2M CaCl₂, 1.9M urea, balance deionized water

90% (0.2M CaCl₂, 1.9M urea, balance deionized water),

10% diethylene alcohol

As noted above, the present invention does not require time consuming and expensive post treatment of the fabric after the graphic has been printed. Depending on the nature of the graphic and the particular dye employed, the fabric may proceed directly from the printing process to rinsing. However, in some cases drying is required, and the drying period may extend from only a few minutes up to about two hours. After drying the fabric may also require heating. If heating is required, it has been found that subjecting the fabric to heating for no longer than about 30 seconds at a temperature of not more than about 300°F is sufficient. Eventually the fabric is rinsed in cold water to remove any excess dye and fixative salts from the fabric. The resulting product is a fabric bearing a sharp clear graphic having excellent edge quality and uniform dye density.

While preferred embodiments have been shown and described, various modifications and substitutions may be made without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of example and not by limitation.

Claims

1. In a method of printing a graphic (50) on fabric (14) of the type wherein a printing mechanism (10) including printing means (16) and support means (12) is provided, said printing means (16) and support means (12) moveable relative to one another, and the printing means (16) is supplied with a dye suitable for printing on the fabric (14), the improvement comprising:

supporting the fabric (14) on the support means (12) with the fabric orientated with respect to X, Y and Z printing axes and a selected location on the fabric aligned with a selected coordinate position on the X, Y and Z printing axes, providing the printing mechanism (10) with data defining a graphic (50) to be printed on a print area of the fabric (14), printing the graphic (50) on the print area of the fabric (14) by means of the printing mechanism (10) according to the data provided, and applying fixative to the print area of the fabric (14) by means of the printing mechanism (10) according to the data provided to fix the graphic (50) to the fabric.

2. The method of claim 1 wherein the step of applying fixative is carried out prior to the step of printing the graphic (50).
- 5 3. The method of claim 1 wherein the step of applying fixative is carried out after the step of printing the graphic (50).
4. The method of claim 1 wherein the step of applying fixative is carried out prior to and after the step of printing the graphic (50).
- 10 5. The method of claim 1 wherein the graphic (50) is a multicolored graphic and the step of printing the graphic (50) is further characterized in that each color comprising the graphic is printed sequentially on a portion of the print area of the fabric (14).
- 15 6. The method of claim 5 wherein the step of applying fixative is further characterized in that the fixative is applied sequentially to a portion of the print area of the fabric (14) corresponding to the portion of the print area printed with each color comprising the graphic (50).
7. A method of printing a graphic on a fabric.

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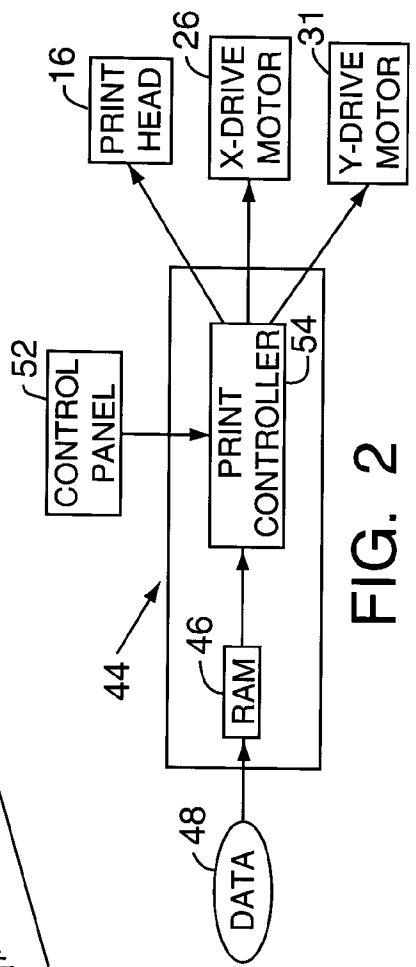
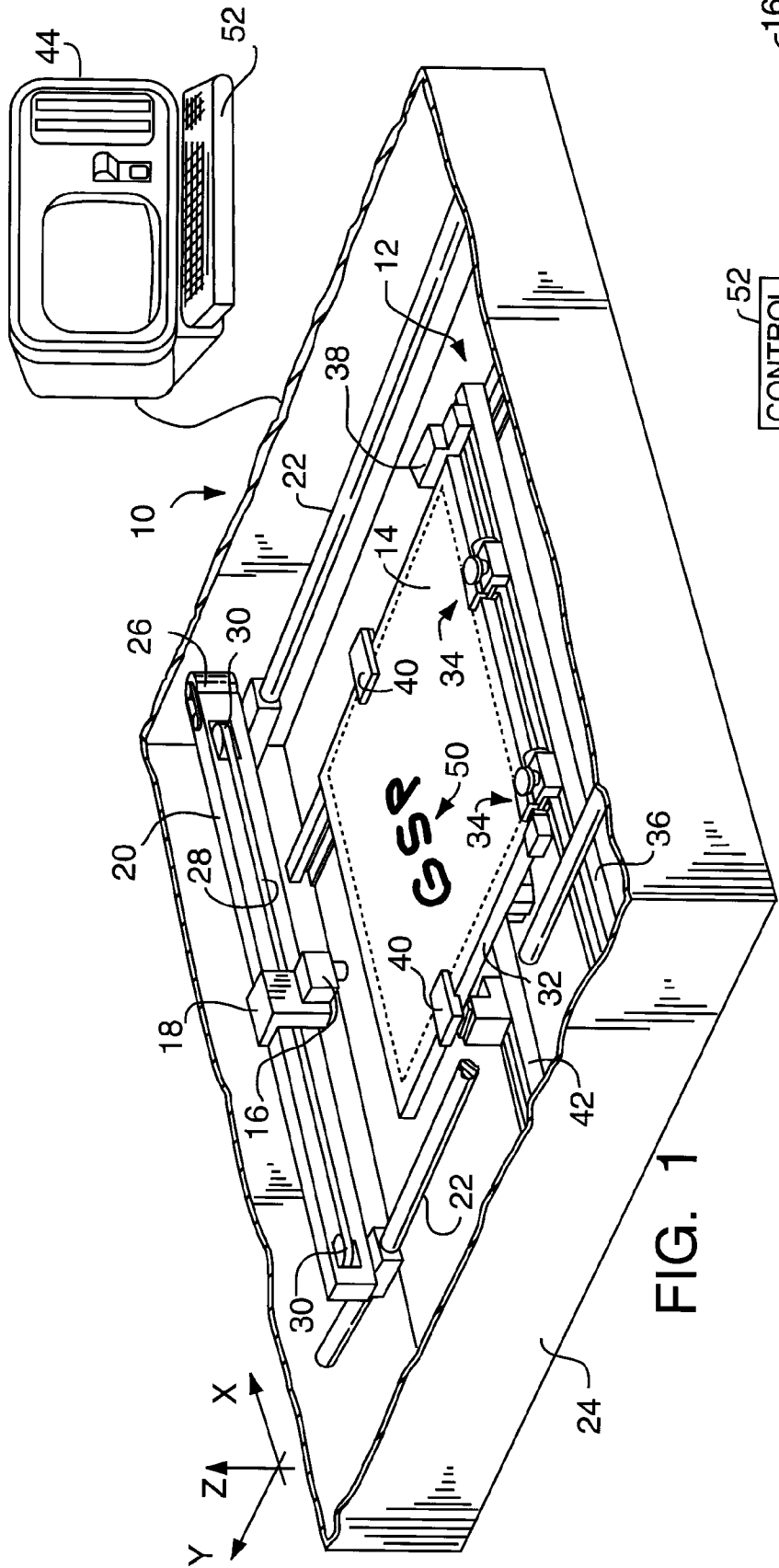
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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 2213

DOCUMENTS CONSIDERED TO BE RELEVANT				
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)	
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X	* page 29, right column, paragraph: " SUBSTRATE PRETREATMENT " *	7		
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The present search report has been drawn up for all claims				
Place of search THE HAGUE		Date of completion of the search 25 August 1995	Examiner Blas, V	
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