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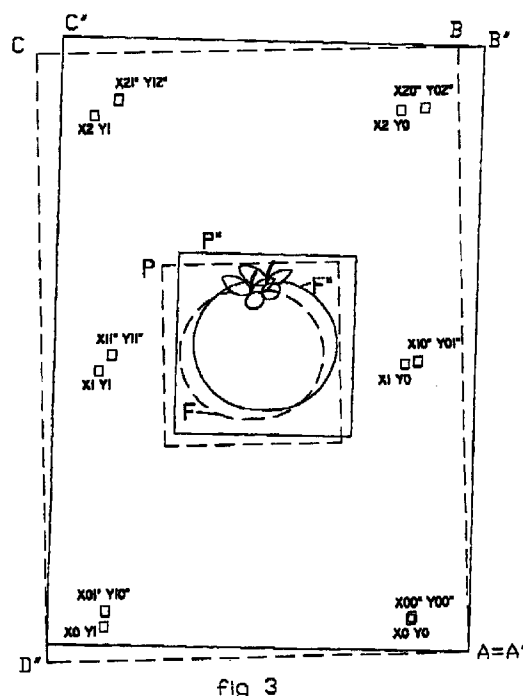
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(54) **Method and device for cutting a pattern in a sheet material**

(57) Method and cutting device for cutting a well-defined pattern in a surface layer of a laminated sheet material, said pattern being positioned in a first predetermined relationship with respect to a figure provided on the sheet material, said method comprising the steps of

- (i) feeding a sheet material into a reproduction apparatus and providing at least three marker prints in a triangular shape on predetermined positions on the sheet material,
- (ii) providing said figure on the sheet material,
- (iii) feeding the sheet material into the cutting device and sensing said marker prints by means of a detector provided with the cutting device,
- (iv) deriving from data provided by the detector the actual positions of the marker prints and deriving transformation relations which transform the predetermined positions of the marker prints into their actual positions, thus taking into account any translation, rotation or distortion of the sheet material fed in the cutting device,
- (v) generating a set of transformed points defining a transformed pattern that is to be positioned in said first relationship with respect to the actual figure on the sheet material in the cutting device, and
- (vi) controlling the cutting device such that a pattern compatible with the first set of transformed points will be cut and cutting said transformed pattern.



EP 0 704 283 A1

Description

The present invention pertains to a method for cutting by using a cutting device a well-defined pattern in a surface layer of a sheet material, which may be laminated, said pattern being defined by a first set of points in a predetermined co-ordinate system, and being positioned in a first predetermined relationship with respect to a figure provided on the sheet material, said figure being well-defined in said co-ordinate system.

Such a method is known in the graphics industry, e.g. for the production of panels and sheets upon which a text, figures and the like are applied. These sheets and panels may e.g. be used as billboards, displays and the like by designers, architects, decorators of exhibition stands and other professionals.

In a well known application of the method, a figure is provided on a laminated sheet by means of a reproduction apparatus, which is composed of a surface layer of a plastic material, e.g. vinyl, releasably attached by means of an adhesive upon an underlayer, e.g. a silicon-wax-coated paper sheet. After a figure has been reproduced, a pattern is to be cut in the surface layer of the laminated sheet material by using a cutting device, which pattern is defined by the contour of the figure. After the cutting operation has been completed the actual figure, i.e. the very part of the surface layer that is bounded by the pattern cut, can be taken out from the surface layer and be transferred to the surface of the very sheet, panel etc. upon which the figure is to be attached. The reproduction apparatus may be any (X,Y) plotter or printer commonly used in the field, like a plotter operating with a roller ball, a drafting pen or a ceramic tip, a laser printer, a thermal printer etc. The reproduction apparatus is provided with a traction- and/or friction system enabling a first relative movement to and fro of the sheet material with respect to the respective plotter or printer in accordance with a first component of a plotting direction and a second relative movement to and fro of the sheet material with respect to the respective plotter or printer in accordance with a second component of said plotting direction. The cutting device may be any (X,Y) cutter or puncher commonly used in the field, like a drag knife cutter, a tangential knife cutter, a laser cutter etc.

It is a drawback of the known method that it is difficult to be able to control the cutting device such that a pattern is cut as determined by the figure on the sheet material. Differences between the calibrations of the reproduction apparatus and the cutting device or slight differences in respective feed-roll diameters might readily lead to translations, rotations or distortions of a sheet material fed into a cutting device, with respect to a co-ordinate system previously determined in the reproduction apparatus. Therefore, the known method puts extreme high requirements on the way the sheet material is fed into the cutting device once the figure has been applied. These requirements are presently tried to be met by using a reproduction apparatus and a reproduction device having the same type of traction and/or friction system. Such a trac-

tion system may incorporate a driving shaft having two sprocket wheels on its both sides, said sprocket wheels having sprockets engaging with perforations provided along the edge zones of an elongate sheet material which is to be fed (in a direction chosen as X-direction) from a roll. The traction system for the relative movement perpendicular to the X-direction (chosen as Y-direction) is then defined with respect to the position of these sprocket wheels. The drawbacks of feeding the sheet material by means of sprocket wheels are several. The perforations may be worn out during the processing in the reproduction apparatus or may be damaged during transportation or handling of the sheet material, whereas slight differences in the perforations at one side and at the other side of the sheet material might lead to distortions of the sheet material and, as a consequence, also to distortions of the pattern to be cut. Further, the perforations may not be positioned well enough to meet high standards of printing and cutting resolution, which might lead to translations or rotations of even also distortions of the pattern to be cut with respect to the figure. Moreover, a traction and/or friction system operating with sprocket wheels puts severe limitations upon the user in his choice of sheet materials, which due to the requirement of perforations may be too expensive or may not be available at all. Other types of traction and/or friction systems, either in a roll-feed system or in a flat-bed system (in which a piece of sheet material is fixed on a plate, in order to have the printing or cutting tool moved with respect to said plate) suffer from similar drawbacks.

It is therefore an object of the present invention to provide a method for cutting a well-defined pattern as described in the introduction, which method enables its user to feed a sheet material on which a figure has been applied in a reproduction apparatus into a cutting device, and having cut a well-defined pattern in a predetermined relationship with said figure while meeting high standards of accuracy and resolution, without suffering from the drawbacks mentioned above.

This object is attained in a method which according to the invention is characterized by the steps of

- (i) feeding a sheet material into a reproduction apparatus and providing at least three marker prints on the sheet material by means of the reproduction apparatus, said marker prints being arranged in a triangular shape on predetermined positions defined by a second set of points in said co-ordinate system,
- (ii) providing said figure on the sheet material,
- (iii) feeding the sheet material into the cutting device and sensing said marker prints by means of a detector provided with the cutting device,
- (iv) deriving from data provided by the detector the actual positions of the marker prints with respect to said co-ordinate system, comparing these actual positions with the predetermined positions and deriving transformation relations which transform the co-ordinates of the predetermined positions into

the actual positions of the marker prints, thus taking into account any translation, rotation or distortion of the sheet material fed in the cutting device,

(v) generating, by means of said transformation relations, from said first set of points a first set of transformed points, said transformed points defining a transformed pattern that is to be positioned in said first relationship with respect to the actual figure on the sheet material in the cutting device, and

(vi) controlling the cutting device such that a pattern compatible with the first set of transformed points will be cut and cutting said transformed pattern. On using the method according to the invention, any translation, rotation or distortion of the sheet material fed into the cutting device with respect to a predetermined co-ordinate system, which gives rise to a corresponding translation, rotation or distortion of the figure on the sheet material, is derived from the actual relative positions of the marker prints and is taken into account when the cutting operation is to be performed, thus maintaining the predetermined relationship in which the pattern cut is positioned with respect to the figure.

According to the method of the invention, the sheet material may be provided with marker prints by means of a first reproduction apparatus, whereas the figure may be provided by means of a second reproduction apparatus.

Preferably, the at least three marker prints and said figure are provided simultaneously by means of one reproduction apparatus.

The number of marker prints is at least three, in order to be able to derive the transformation relations which describe the transformation of any point on the (two-dimensional) surface of the sheet material. From the latter it is evident that it is not required that the marker prints are necessarily separated from each other: a combination of an elongated stripe and a dot laying off-side that stripe can also to be used and interpreted as a combination of three marker prints, having two marker prints located at both remote ends of the stripe, connected by said stripe, and having the third marker print located on a lateral position.

In an embodiment of the method according to the invention, a very accurate way of cutting, meeting standards of extreme high resolution and reproducibility on going from one pattern to be cut to another one, is attained if the at least three marker prints in step (i) are a plurality of marker prints, laying in two parallel rows along opposite edge zones of the sheet material, having equal mutual distances within each row.

Such a configuration of marker prints is especially advantageous in cases where the sheet material is to be fed into the cutting device by means of a roll-feed system.

The invention also relates to an apparatus for reproducing a figure on a sheet material, which material may be laminated, said figure being well-defined in a predetermined co-ordinate system.

According to the invention, said apparatus is characterized by means to provide at least three marker prints on the sheet material, said marker prints being arranged in a triangular shape on predetermined positions defined by a set of points in said co-ordinate system, and being adapted to be sensed by a detector provided in a cutting device, such that a predetermined pattern being positioned with respect to the figure in a first predetermined relationship can be cut in a surface layer of the sheet material according to a method as disclosed above.

The invention further relates to a device for cutting according to the above disclosed method a well-defined pattern in a surface layer of a sheet material, which may be laminated, said pattern being defined by a first set of points in a predetermined co-ordinate system, and being positioned in a first predetermined relationship with respect to a figure provided on the sheet material, said figure being well-defined in said co-ordinate system, said cutting device being characterized by detector means and data processor means as claimed in claim 4.

In an embodiment of a device according to the invention, the detector means comprise a light source, projecting a scanning light beam upon the surface layer to be reflected by that layer, and a light sensor detecting the reflected beam.

Preferably, the light beam is to be scanned in two mutual substantial perpendicular directions.

In an alternative embodiment, the detector means comprise a bar code reader device, which is known by its very fast, accurate and reliable performances.

In another embodiment, the detector means comprises a charge coupled device (CCD), enabling a very accurate localisation of the marker prints on the sheet material.

The objects, features and advantages of the present invention will be more readily apparent from the detailed discussion of an embodiment, set forth below, taken in conjunction with the accompanying drawings.

Figure 1 schematically shows a rectangular piece of sheet material, as to be fed into a (X, Y) reproduction apparatus.

Figure 2 shows the piece of sheet material of figure 1 after distortion due to an elongation both in length and width.

Figure 3 shows the piece of sheet material of figure 1 after a rotation around an axis perpendicular to this piece.

In figure 1, the sheet material is indicated by its corners A, B, C and D. In the reproduction apparatus (not shown) a figure F, in this case depicting a tomato, a square frame P around the figure, and marker prints X_i, Y_0 and X_i, Y_1 (in which $i = 0, 1, 2$) are applied upon the sheet material, along the edge zones AB and DC respectively. A pattern, defined by the square frame P of the figure, is to be cut in the sheet material in a (X, Y) cutting device. By means of three marker prints, e.g. X_0, Y_0, X_2, Y_0 and X_2, Y_1 , a co-ordinate system is established in

which each point of figure F, and therefore each point of the pattern P to be cut, is uniquely defined.

After having fed the sheet material into a cutting device, it may occur that the sheet material is translated or rotated with respect to the starting position of the cutting tool in the cutting device, which position is defined by the co-ordinates of the pattern to be cut, in this example the frame P of figure F. In an even worse situation the sheet material might be distorted, leading to a distortion of figure F.

In figure 2 a situation in which a distortion occurs is schematically shown. The solid quadrangle A'B'C'D' represents the sheet material as fed into the cutting device, in a distorted position with respect to the position ABCD (indicated by dashed lines) the sheet material had in the reproduction apparatus, due to an elongation of both the length A'B' and the width A'D' in comparison with the original length AB and width AD respectively. As a consequence, both the figure F and the marker prints X_i, Y_i (in which $i = 0, 1, 2$) are transformed to respectively the figure F' (tomato depicted in solid lines) and marker prints X_i', Y_i' . In the cutting device a detector senses the actual marker prints X_i', Y_i' and sends data to a data processor, from which data the actual positions of the marker prints X_i', Y_i' are derived. Data comprizing the predetermined positions of the marker prints, as were used in the reproduction apparatus on applying the marker prints on the sheet material, have also been sent to the data processor, in which now the transformation relations which transform the co-ordinates of the predetermined positions into the actual positions of the marker prints are derived from a comparison of the actual positions of the marker prints with their predetermined positions. Then, by means of these transformation relations, each point defining figure F is transformed to a point defining the transformed figure F', thus transforming the square frame P of F into the frame P' of figure F'. Frame P' is not a square anymore, but still positioned in the same relationship with figure F' as frame P was positioned with respect to figure F. Data comprizing the frame P' are now applied to control the cutting device on cutting said contour.

In figure 3 a situation in which a rotation occurs is schematically shown. The solid quadrangle A"B"C"D" represents the sheet material as fed into the cutting device, in a rotated position with respect to the position ABCD (indicated by dashed lines) the sheet material had in the reproduction apparatus. This will occur if the sheet material is not fed correctly into the cutting device, by not maintaining the edge AB parallel with the feed direction of the device. As a consequence, both the figure F and the marker prints X_i, Y_i (in which $i = 0, 1, 2$) are transformed to respectively the figure F" (tomato depicted in solid lines) and marker prints X_i'', Y_i'' . Again, in the cutting device a detector senses the actual marker prints X_i'', Y_i'' and sends data to a data processor, from which data the actual positions of the marker prints X_i'', Y_i'' are derived. Data comprizing the predetermined positions of the marker prints, as were used in the reproduction apparatus

on applying the marker prints on the sheet material, have also been sent to the data processor, in which now the transformation relations which transform the co-ordinates of the predetermined positions into the actual positions of the marker prints are derived from a comparison of the actual positions of the marker prints with their predetermined positions. Then, by means of these transformation relations, each point defining figure F is transformed to a point defining the transformed figure F", thus transforming the square frame P of F into the frame P" of figure F". Frame P" will be a square if only rotation of the sheet occurred, it will not be a square any more if also a distortion occurred, as was shown in figure 2. In any case, frame P" will still be positioned in the same relationship with figure F" as frame P was positioned with respect to figure F. Data comprizing the frame P" are now applied to control the cutting device on cutting said contour.

Applying this method in a cutting device according to the invention, the pattern that is actually cut is positioned in the predetermined relationship with the figure on the sheet material, irrespective any deformation of said material that might occur in the period between the printing and cutting processes, and irrespective the peculiar types and specifications of the (X,Y) reproduction apparatus and cutting device that are used.

In the above examples the marker prints X_0, Y_0, X_2, Y_0 and X_2, Y_1 have been chosen as the points defining the co-ordinate system in which the points of figure F can be expressed for reasons of clarity. It will readily be understood that this choice is an arbitrary one. In fact any set of marker prints not laying on a straight line can be selected to define a co-ordinate system for any figure F to be applied on the sheet material. The actual number, shape and position of marker prints will depend on many aspects, like the specifications of sheet material and (components of) reproduction apparatus and cutting device, and the accuracy of the pattern position with respect to the figure F to be attained.

Claims

1. Method for cutting by using a cutting device a well-defined pattern in a surface layer of a sheet material, which may be laminated, said pattern being defined by a first set of points in a predetermined co-ordinate system, and being positioned in a first predetermined relationship with respect to a figure provided on the sheet material, said figure being well-defined in said co-ordinate system, characterized by the steps of

(i) feeding a sheet material into a reproduction apparatus and providing at least three marker prints on the sheet material by means of the reproduction apparatus, said marker prints being arranged in a triangular shape on predetermined positions defined by a second set of points in said co-ordinate system,

(ii) providing said figure on the sheet material,
 (iii) feeding the sheet material into the cutting device and sensing said marker prints by means of a detector provided with the cutting device,
 (iv) deriving from data provided by the detector the actual positions of the marker prints with respect to said co-ordinate system, comparing these actual positions with the predetermined positions and deriving transformation relations which transform the co-ordinates of the predetermined positions into the actual positions of the marker prints, thus taking into account any translation, rotation or distortion of the sheet material fed in the cutting device,
 (v) generating, by means of said transformation relations, from said first set of points a first set of transformed points, said transformed points defining a transformed pattern that is to be positioned in said first relationship with respect to the actual figure on the sheet material in the cutting device, and
 (vi) controlling the cutting device such that a pattern compatible with the first set of transformed points will be cut and cutting said transformed pattern.

2. Method as claimed in claim 1, characterized in that the at least three marker prints and said figure are provided simultaneously by means of one reproduction apparatus.
3. Method as claimed in claim 1, characterized in that the at least three marker prints in step (i) are a plurality of marker prints, laying in two parallel rows along opposite edge zones of the sheet material, having equal mutual distances within each row.
4. Apparatus for reproducing a figure on a sheet material, which material may be laminated, said figure being well-defined in a predetermined co-ordinate system, characterized by means to provide at least three marker prints on the sheet material, said marker prints being arranged in a triangular shape on predetermined positions defined by a set of points in said co-ordinate system, and being adapted to be sensed by a detector provided in a cutting device, such that a predetermined pattern being positioned with respect to the figure in a first predetermined relationship can be cut in a surface layer of the sheet material according to a method as claimed in claim 1.
5. Device for cutting according to the method of claim 1 a well-defined pattern in a surface layer of a sheet material, which may be laminated, said pattern being defined by a first set of points in a predetermined co-ordinate system, and being positioned in a first predetermined relationship with respect to a figure provided on the sheet material, said figure

being well-defined in said co-ordinate system, characterized by

- detector means for sensing marker prints provided on the surface layer, and
 - data processor means for deriving from the data provided by the detector means the actual positions of the marker prints with respect to said co-ordinate system, comparing these actual positions with the predetermined positions and deriving transformation relations which transform the co-ordinates of the predetermined positions into the actual positions of the marker prints, thus taking into account any translation, rotation or distortion of the sheet material fed in the cutting device, generating, by means of said transformation relations, from said first set of points a first set of transformed points, said transformed points defining a transformed pattern that is to be positioned in said first relationship with respect to the actual figure on the sheet material in the cutting device, and controlling the cutting device such that a pattern compatible with the first set of transformed points will be cut.
6. Device as claimed in claim 5, characterized in that the detector means comprise a light source, projecting a scanning light beam upon the surface layer to be reflected by that layer, and a light sensor detecting the reflected beam.
 7. Device as claimed in claim 6, characterized in that the light beam is to be scanned in two mutual substantial perpendicular directions.
 8. Device as claimed in claim 5, characterized in that the detector means comprise a bar code reader device.
 9. Device as claimed in claim 5, characterized in that the detector means comprise a charge coupled device (CCD).

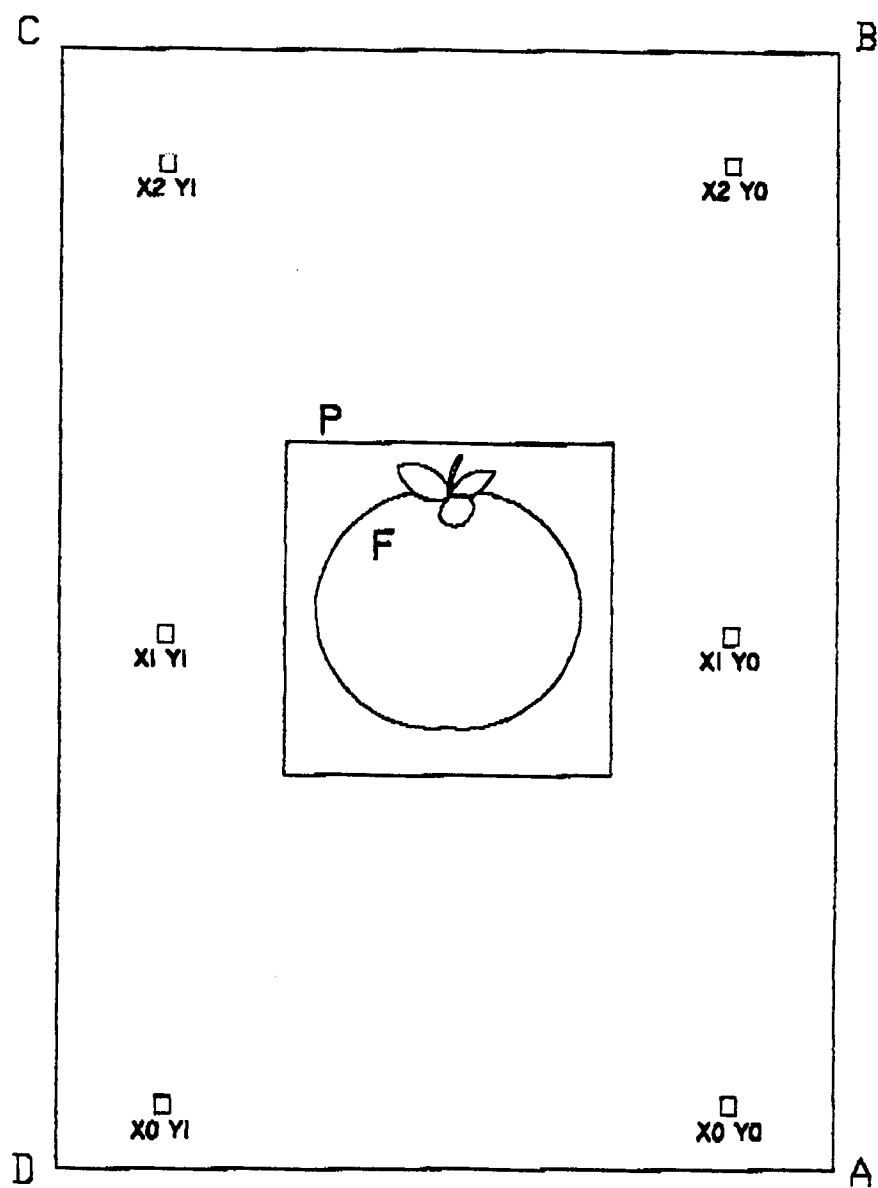


fig 1

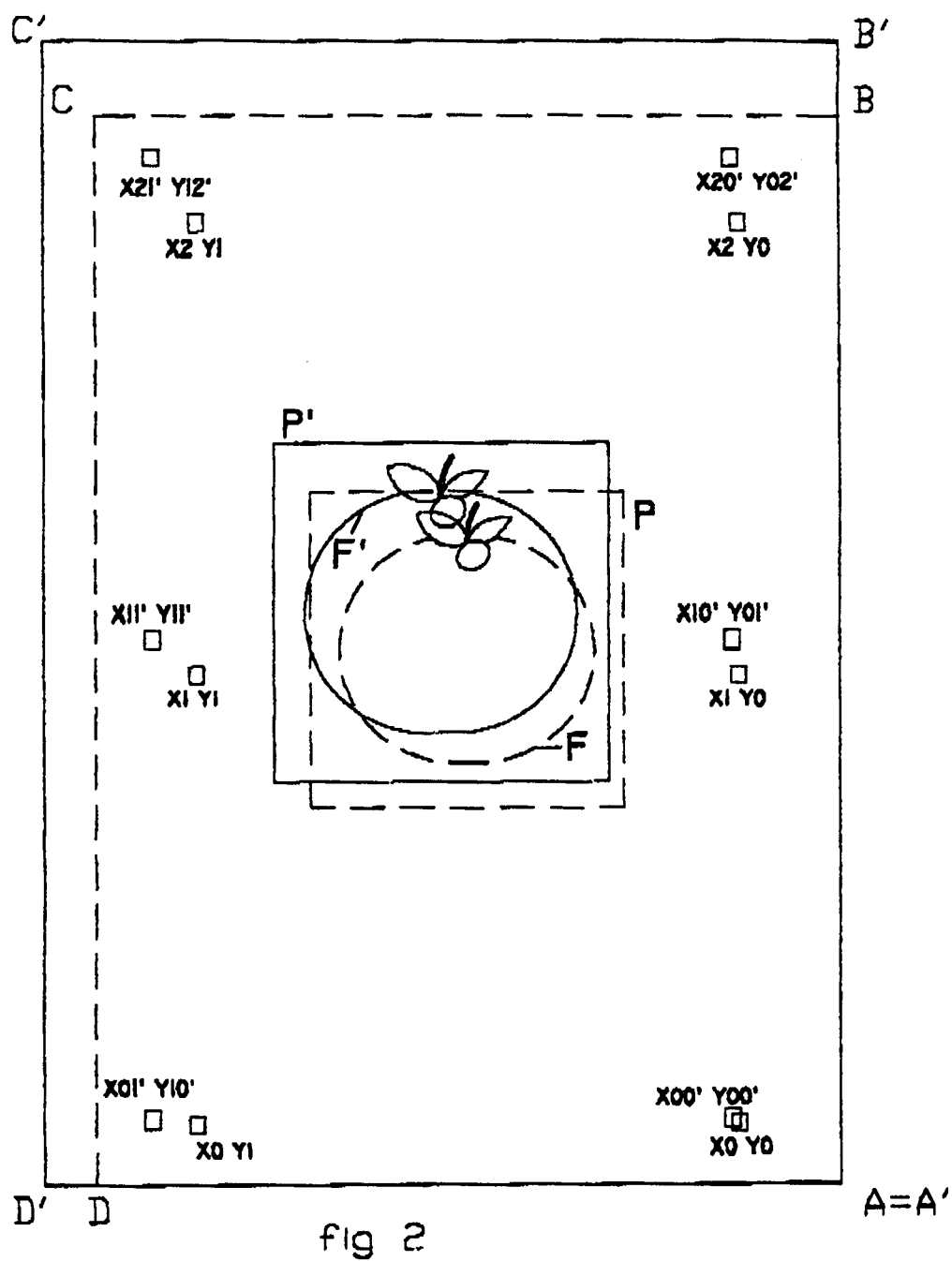


fig 2

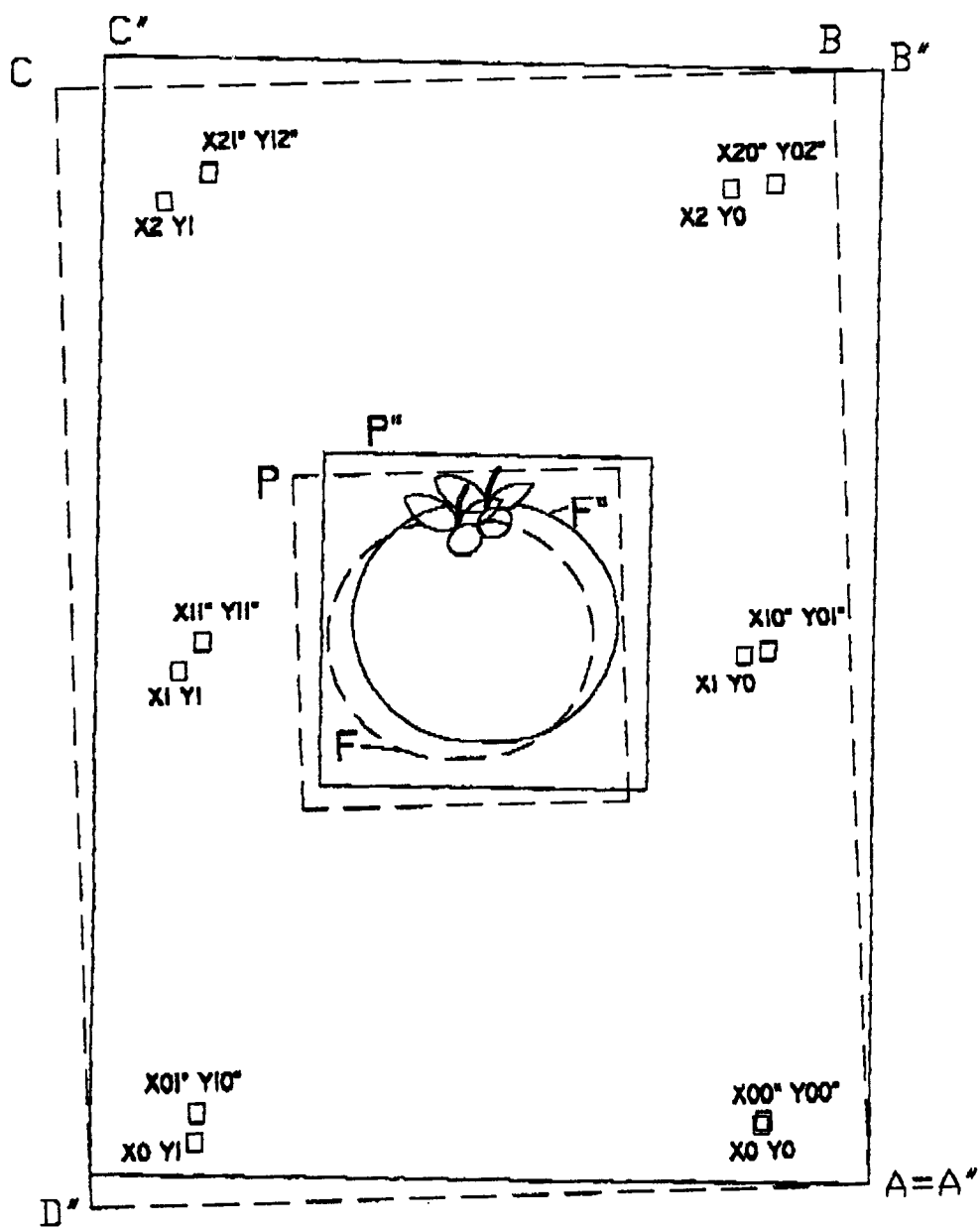


fig 3



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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 2640

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)
Y	EP-A-0 607 539 (GERBER SCIENTIFIC PRODUCTS INC.) * claims 1-3 * ---	1,2,5-7, 9	B26D5/00 B26D7/27 B26F1/38
Y	US-A-4 961 149 (SCHNEIDER ET AL.) * the whole document * ---	1,2,5-7, 9	
A	GB-A-2 270 604 (GERBER GARMENT TECHNOLOGY INC.) * abstract * ---	3,4	
A	WO-A-91 15342 (HASTINGS) * page 4, line 21 - page 5, line 19 * -----	8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B26D B26F A41H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 February 1995	Examiner Vaglianti, G
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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