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(54) **APPARATUS FOR MAKING DECORATIONS ON AT LEAST ONE SHEET-LIKE MEDIUM AND PROCESS FOR CALIBRATING SAID APPARATUS**

VORRICHTUNG ZUR HERSTELLUNG VON DEKORATIONEN AUF MINDESTENS EINEM BLATTMÄSSIGEN MEDIUM UND VERFAHREN ZUR KALIBRIERUNG DER VORLIEGENDEN VORRICHTUNG

APPAREIL PERMETTANT DE DÉCORER SUR AU MOINS UN SUPPORT EN FEUILLE ET PROCÉDÉ D'ÉTALONNAGE DUDIT APPAREIL

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Description

Field of application

[0001] The present invention regards an apparatus for making decorations on at least one sheet-like medium and a process for calibrating the aforesaid apparatus, according to the preamble of the respective independent claims.

[0002] The present apparatus and the process are intended to be employed in the textile field in order to make decorations of very different shapes and colors on sheet-like media, such as fabrics and leathers, by means of embroideries, or more generally stitching, and subsequent laser cuts along the border of the stitches themselves.

[0003] More particularly, the apparatus, object of the present invention, is advantageously employable for attaining embroideries on a sheet-like medium, which are precisely trimmed by a laser cutting that cuts the sheet-like medium along the internal or external edges of the embroidery, so as to make decorations with the desired shapes and sizes. The invention is therefore inserted in the context of the industrial field of textile machine production.

State of the art

[0004] Apparatuses for making decorations on at least one sheet-like medium are known on the market; these are aimed to make stitching and subsequent laser cuts along the border of the stitches. Such apparatuses require carrying out the two operations of stitching and laser cutting on the same sheet-like medium in a progressive and precise manner over time in order to engrave the sheet-like media, such as fabrics or leathers, exactly at a predefined distance from the edge of the stitching.

[0005] Therefore, in this specific sector of the textile industry, there is the particular need to be able to precisely cut the borders of the sewn decoration figure (whether it is a complex design, a letter or a logo) without damaging the sheet-like medium, for example for making decorations of appliqué type (with multiple layers of superimposed sheet-like media) or of lace type (with only one embroidered and perforated layer).

[0006] Apparatuses have been known on the market for some time which make decorations by means of the combination of one or more embroidering heads with a laser cutting head, which are associated with a same work surface on which one or more sheet-like media to be decorated are arranged.

[0007] More in detail, the embroidering heads of the apparatuses of known type are provided with at least one operating head which carries, mounted thereon, one or more needles movable along a direction perpendicular to the underlying work surface in order to execute the provided and programmed stitching operations. In addition, the embroidering heads are in turn movable with respect to the work surface in order to trace the figure to be sewn. For example, each embroidering head is movable along a first guide arranged parallel to the longitudinal extension direction of the work surface and along a second guide arranged transverse to the longitudinal extension direction of the work surface.

[0008] Also known is the embodiment that is kinematically substantially equivalent, in which the embroidering heads are fixed and it is the work surface to be movable with respect to the latter, e.g. along two guides parallel to the longitudinal and transverse extension directions thereof.

[0009] The aforesaid laser cutting heads of the apparatuses of known type are provided with a laser source (e.g. CO_2) adapted to generate a laser beam and with a series of optical guide means (e.g. mirrors and/or lenses) adapted to direct the laser beam towards the underlying work surface. Based on the power of the laser beam, and on its stay period in a specific point, it is able to engrave, cut or burn the sheet-like medium on which it is directed.

[0010] Also the laser cutting head is movable with respect to the work surface. For example, it is susceptible of sliding along a third guide arranged parallel to the longitudinal extension direction of the work surface, in order to be moved at each embroidering head and execute engraving and/or cutting works at the stitching executed by each embroidering head.

[0011] The apparatuses of known type briefly described up to now have the particular characteristic of using two separate movement systems, one for the embroidering heads and one for the laser cutting head. Hence, these require an exact and coordinated calibration of the two movement systems in order to ensure that the cutting/engraving is attained exactly at the edge of the stitching.

[0012] One drawback of the above-described apparatuses of known type lies in the difficulty of obtaining a precise calibration of the two movement systems, which can lead to attaining a decoration in which the cutting of the laser beam does not correctly follow the stitching, e.g. at some points going too far outside the edge of the stitching or in other points going too far inside the edge of the stitching.

[0013] In order to ensure the exact alignment between the cutting and the edge of the stitching previously attained by the embroidering heads, in the apparatuses of known type a periodic calibration is executed of the systems for moving the embroidering heads and the laser cutting head.

[0014] More in detail, the calibration is executed by making, with each embroidering head, a series of blank stitches by means of the needle (but without using the thread) on a sheet-like medium; subsequently, a series of laser beams is projected on the same sheet-like medium, which must trace the blank stitches attained by the embroidering head.

[0015] If the blank stitches and the laser beams are not exactly coinciding, provision is made for adjusting the

position of each laser beam until it is exactly superimposed on the corresponding blank stitch.

[0016] For example, it is known to calibrate by means of a 9-point matrix (points arranged along three rows and three columns) and with six laser beams (three horizontal and three vertical). The two movement systems are exactly calibrated when the six laser beams are exactly intersected with each other at the nine points of the matrix.

[0017] Since, during the operating life thereof, such apparatuses are subjected to considerable vibrations which can lead to the onset of mechanical clearances, it is opportune to periodically repeat the aforesaid calibration so as to avoid losing the collimation of the two movements. In addition, the calibration is to be repeated for each embroidering head, since each of these is subjected to different mechanical stresses, depending on its position along the extension of the work surface.

[0018] It is easy to perceive that a similar calibration process, if manually carried out, requires rather long times and hence prolonged machine stops, specialized personnel, and in any case does not allow obtaining a high quality standard.

[0019] Known from the patent EP 3167996 is an apparatus for making decorations by means of stitching and laser cutting, which is provided with an image acquisition device adapted to acquire the stitches made by the embroidering heads and the laser beams projected by the laser cutting head. Such apparatus of known type is also provided with an electronic calibration unit comprising means of comparing the acquired images, which are capable of evaluating the difference of position between the blank stitches and the laser beams and automatically adjusting the position of the laser beams projected by the laser cutting head in order to carry out the above-described calibration.

[0020] Nevertheless, even the apparatus described in the patent EP 3167996 has in practice proven that it does not lack drawbacks.

[0021] The main drawback of such apparatus of known type lies in the fact that the calibration carried out on the blank stitches is not sufficient for ensuring a precise cutting of the borders of the stitching. Indeed, during the embroidery step, the sheet-like medium on which the stitching is executed - due to tensions imposed by the stitching thread - can sustain small movements, such as rotations or translations with respect to the original position or it can sustain small deformations such as elongations in one direction. Hence, the figure obtained in the embroidery step does not exactly correspond to the theoretical figure to be attained, but is moved and/or deformed like the sheet-like medium on which it is made, and consequently the laser cutting head is no longer able to precisely cut the borders of the embroidered figure. Consequently, the cutting is non-centered with the embroidered figure and the final effect does not have satisfactory quality. Such negative circumstance is worsened in the case of embroideries which require very dense/packed stitches or if the cutting of the laser head must very closely follow the border of the embroidered figure.

[0022] In operation, therefore, the calibration of known type carried out on the blank stitches is at least partly made futile by the effect of the distortion of the sheet-like medium due to the embroidery step.

Presentation of the invention

[0023] In this situation, the problem underlying the present invention is therefore that of overcoming the drawbacks manifested by the apparatuses of known type, by providing an apparatus for making decorations on at least one sheet-like medium capable of improving the cutting precision along the edges of a stitch.

[0024] A further object of the present invention is to provide an apparatus for making decorations on at least one sheet-like medium which does not require a periodic blank calibration.

[0025] A further object of the present invention is to provide an apparatus for making decorations on at least one sheet-like medium which is precise and reliable in use.

[0026] A further object of the present invention is to provide an apparatus for making decorations on at least one sheet-like medium which is inexpensive and simple to use in operation.

Brief description of the drawings

[0027] The technical characteristics of the invention, according to the aforesaid objects, can be clearly seen in the contents of the below-reported claims and the advantages thereof will be more evident in the following detailed description, made with reference to the enclosed drawings, which represent a merely exemplifying and non-limiting embodiment of the invention, in which:

- Fig. 1 shows a perspective view of the apparatus for making decorations on at least one sheet-like medium, object of the present invention;
- Fig. 2 shows a schematic view of the comparison between the theoretical figure to be embroidered and that actually embroidered following the translation of the sheet-like medium during the embroidery step;
- Fig. 3 shows a schematic view of the comparison between the theoretical figure to be embroidered and that actually embroidered following the rotation of the sheet-like medium during the embroidery step;
- Fig. 4 shows a schematic view of the comparison between the theoretical figure to be embroidered and that actually embroidered following the translation and shortening of the sheet-like medium during the embroidery step;
- Fig. 5 shows a block diagram indicating the main parts of the apparatus, object of the present invention, and the relations between them.

Detailed description of a preferred embodiment

[0028] With reference to the enclosed drawings, reference number 1 overall indicates an apparatus for making decorations on at least one sheet-like medium, object of the present invention.

[0029] The apparatus 1, according to the invention, is intended to be employed for making decorations such as embroideries and laser cuts on one or more sheet-like media.

[0030] With the term "embroidery", any one stitching will be intended hereinbelow that is aimed to make more or less complex figures, such as for example designs, letters or logos, on a sheet-like medium, or on multiple superimposed sheet-like media.

[0031] With the term "sheet-like medium" any one medium type will be intended hereinbelow that can be embroidered and cut, such as for example fabrics and leather/skins, but also cloth, non-woven fabrics, paper sheets and other items; these are mainly extended along two dimensions.

[0032] The apparatus 1, object of the present invention, comprises a support structure 2 to which at least one substantially horizontal work surface 3 is fixed, on which at least one sheet-like medium S to be embroidered and cut is adapted to be positioned; and at least one embroidering head 4 and one laser cutting head 6 for embroidering and cutting the sheet-like medium S.

[0033] In accordance with the embodiment illustrated in figure 1, the apparatus 1 comprises multiple embroidering heads 4 mounted on the support structure 2 and arranged along the work surface 3. Each of such embroidering heads 4 is adapted to embroider at least one figure F on a work area L of the sheet-like medium S.

[0034] In a per se known manner, the embroidering heads 4 are provided with at least one operating head 5 which carries, mounted thereon, one or more needles movable along a direction perpendicular to the underlying work surface 3 and one or more reels of thread of different colors and materials, which are susceptible of being guided by the needles to traverse the sheet-like medium S in order to execute the embroidery.

[0035] Each embroidering head 4 is mounted on the support structure 2 and is actuatable to be moved with respect to the work surface 3 by means of first movement means 10 in order to trace the figure F.

[0036] In accordance with a preferred embodiment, the aforesaid first movement means 10 comprise a first guide arranged along a first direction X, substantially parallel to the longitudinal extension direction of the work surface 3, and a second guide arranged along a second direction Y, substantially transverse to the longitudinal extension direction of the work surface 3.

[0037] Advantageously, the embroidering head 4 is slidably mounted on the first guide and is susceptible of advancing along the latter. Advantageously, moreover, the first guide is in turn slidably mounted on the second guide and is susceptible of advancing along the latter.

[0038] In operation, while the needle of each embroidering head 4 is moved perpendicularly to the sheet-like medium S and guides the thread through the latter in order to execute the stitches of the embroidery, the embroidering head 4 is moved along the work surface 3 in order to trace the figure F to be embroidered.

[0039] Of course, also forming the object of the present invention is the embodiment that is kinematically substantially equivalent, in which the embroidering heads 3 are fixed and it is the work surface 2 that is movable with respect to the latter, e.g. along two guides parallel to its longitudinal and transverse extension directions. Such embodiment is commonly known to the man skilled in the art and thus will not be further described hereinbelow.

[0040] The laser cutting head 6 of the apparatus 1, object of the present invention, is adapted to cut the sheet-like medium S along at least one border (internal or external) of the figure F previously sewn by the embroidering head 4.

[0041] In a per se known manner, the laser cutting heads 6 are provided with a laser source, e.g. CO_2, adapted to generate a laser beam, and with a series of optical guide means, such as mirrors and/or lenses, which are adapted to direct the laser beam towards the underlying work surface 3 and to move it along the work area L in order to trace the borders of the figure F to be cut.

[0042] The laser cutting head 6 is in turn mounted on the support structure 2 and is actuatable to be moved with respect to the work surface 3 by means of second movement means 20.

[0043] In accordance with the embodiment illustrated in figure 1, the second movement means 20 comprise a third guide 7 arranged parallel to the first direction X. Advantageously, the laser cutting head 6 is slidably mounted on the third guide 7 and is susceptible of advancing along the latter in order to be moved at each embroidering head 4 and execute cutting work at the stitching executed by each embroidering head 4. Advantageously, the work surface 3 is associated with a Cartesian plane, in which the aforesaid first and second direction X, Y respectively correspond to the x-axis and to the y-axis. In this manner, each position reached by the embroidering heads 4 and by the laser cutting head 6 on the work surface 3 can be indicated with a pair of Cartesian coordinates taken along the x-axis and y-axis starting from a point of origin O, e.g. identifiable with one edge of the work surface 3. Advantageously, also the figure F to be embroidered and cut can be defined by means of a series of points belonging to the Cartesian surface associated with the work surface 3.

[0044] Advantageously, the apparatus 1 comprises a first electronic control unit 100 connected to the first movement means 10 and adapted to guide each embroidering head 4 according to an embroidery program in which the figure F to be embroidered is defined with respect to the Cartesian plane associated with the work surface 3.

[0045] In addition, the apparatus 1 advantageously

comprises a second electronic control unit 200 connected to the second movement means 20 and adapted to guide the laser cutting head 6 according to a cutting program that is defined with respect to the Cartesian plane associated with the work surface 3. In particular, the second electronic control unit 200 guides the laser cutting head 6 along the internal or external perimeter of the figure F defined with respect to the Cartesian plane.

[0046] In accordance with the block diagram of figure 5, the first and the second electronic control unit 100, 200 are part of a single central control unit 300 adapted to guide the embroidering heads 4 and the laser cutting head 6.

[0047] According to the invention, the apparatus 1 also comprises at least one image acquisition device 8 mounted on the support structure 2, directed towards the work surface 3 and actuatable to be moved with respect to the latter by means of third movement means 30.

[0048] More in detail, the image acquisition device 8 comprises a camera, adapted to frame a specific reading area, and image processing means, adapted to identify the information contained within the reading area of the camera. In a known manner, the camera and the image processing means can advantageously be integrated in a single smart camera. Advantageously, the third movement means 30 of the image acquisition device 8 comprise a fourth guide arranged parallel to the first direction X, and along such fourth guide the image acquisition device 8 is susceptible of sliding.

[0049] In accordance with a different embodiment, the third guide 7 of the second movement means 20 and the fourth guide of the third movement means 30 coincide and the laser cutting head 6 and the image acquisition device 8 are susceptible of sliding along the same guide.

[0050] In accordance with a further embodiment, the image acquisition device 8 is mounted on the laser cutting head 6. In the latter case, the third movement means 30 advantageously comprise a robotic arm which allows moving the image acquisition device 8 in order to move its reading area and frame multiple sectors of the underlying sheet-like medium S. Advantageously, the central control unit 300 is connected to the third movement means 30 and is configured for guiding the image acquisition device 8. In accordance with a different embodiment, the image processing means of the image acquisition device 8 can be integrated in the central control unit 300.

[0051] The apparatus 1, object of the present invention, also comprises at least one electronic calibration unit 400 connected to the image acquisition device 8 and to the laser cutting head 6.

[0052] Advantageously, the electronic calibration unit 400 can be part of the second electronic control unit 200 of the laser cutting head 6, or of the central control unit 300.

[0053] The electronic calibration unit 400 is configured for receiving the information detected by the image acquisition device 8 and for actuating the second movement means 20 in order to position the laser cutting head 6 on the sheet-like medium S on the basis of the received information.

[0054] According to the idea underlying the present invention, the image acquisition device 8 is configured for detecting the position of at least one marker 9, applied on the sheet-like medium S, in at least one first and one second time instant t1, t2, respectively before and after the execution of the embroidery of the figure F by the embroidering head 4.

[0055] In addition, the electronic calibration unit 400 is configured for comparing the position of the marker 9 acquired in the first time instant t1 with the position acquired in the second time instant t2 and for determining the position variation sustained by the marker 9 between the first and the second time instant t1, t2 with respect to a reference on the work surface 3. For example, with respect to the Cartesian plane associated with the work surface 3 and preferably with respect to its point of origin O.

[0056] In addition, the electronic calibration unit 400 is configured for driving the second movement means 20 to move the laser cutting head 6, collimating it with the position of the figure F embroidered by the embroidering head 4, obtained from the position variation of the marker 9 with respect to the reference.

[0057] For such purpose, advantageously, the electronic calibration unit 400 is provided with multiple functional modules, such as:

- a comparison module 400' configured for comparing the positions of the marker 9 acquired in the first and second time instant t1, t2;
- a calculation module 400" configured for determining the position variation sustained by the marker 9 between the first and the second time instant t1, t2 with respect to the reference on the work surface 3;
- a drive module 400'" configured for driving the second movement means 20 to move the laser cutting head 6, collimating it with the position of the figure F embroidered by the embroidering head 4, obtained from the position variation of the marker 9 with respect to the reference on the work surface 3.

[0058] Preferably, the aforesaid comparison, calculation and drive modules 400', 400", 400'" of the electronic calibration unit 400 are implemented by means of a same processor provided with specific implementation programs (which for example can be shared by a processor of the second control unit 200 or by the central control unit 100). Otherwise, one or more of the aforesaid modules can be implemented by means of corresponding hardware circuits.

[0059] Advantageously, the image acquisition device 8 is susceptible of identifying the position of the marker 9 in the two time instants t1, t2 and of converting such positions into Cartesian coordinates, taken with respect to the point of origin O of the Cartesian plane associated

with the work surface 3.

[0060] Preferably, the central control unit 100 has a control program installed therein, which as a function of the embroidery operations of the embroidering head 4 determined by the first control unit 100, drives the camera of the image acquisition device 8 to acquire at least one first image of the reading area (containing the marker 9) in the first time instant t1 (before the execution of the embroidery) and to acquire at least one second image of the reading area in the second time instant t2 (after the embroidery). Then, the aforesaid control program drives the image processing means of the image acquisition device 8 to determine the position of the marker 9 in each of the aforesaid images, in particular according to a processing process described more in detail hereinbelow. Suitably, the aforesaid control program and the image processing means can be implemented by means of a same software module of a same processor (e.g. of the central control unit 100) for example provided with dedicated routines.

[0061] Each position of the marker 9 is then sent to the electronic calibration unit 400, which is configured for comparing the two coordinates with each other and determining the position variation that occurred between the two time instants.

[0062] Advantageously, the position variation sustained by the marker 9 during the embroidery step can be considered equal to the average position variation sustained by the entire work area L over which the embroidering head 4 operates, and consequently equal to the position variation sustained by the actually embroidered figure F, with respect to the theoretical figure to be embroidered.

[0063] In particular, the electronic calibration unit 400 is then configured for providing the position variation to the second electronic control unit 200 of the laser cutting head 6, which in turn is configured for modifying the cutting program, consistent with the received position variation, and for embroidering the position of the edges of the actually embroidered figure F with reference to the Cartesian plane associated with the work surface 3.

[0064] The second electronic control unit 200 then guides the second movement means 20 to move the laser cutting head 6 to the position of the actually embroidered figure F and drives the cutting of its edges.

[0065] Advantageously, in accordance with a preferred embodiment of the present invention, the marker 9 is an adhesive element, for example provided with a surface covered with a glue layer. In operation, the marker 9 is thus applicable by an operator on the sheet-like medium S before the execution of the embroidery and is removable after the laser cut, without leaving any trace on the sheet-like medium S itself.

[0066] Advantageously, moreover, the marker 9 is applied on the sheet-like medium S outside the work area L of each embroidering head 4, so as to not obstruct the embroidery work. In this manner, the marker 9 is advantageously reusable in subsequent decorations, thus allowing a savings of raw material.

[0067] Preferably, the marker 9 is colored with a color contrasting with the color of the sheet-like medium S on which it is applied, in order to be easily detected by the image acquisition device 8. For example, the marker 9 is a yellow circle, at whose interior a black cross is traced. In this case, the position of the marker 9 detected by the image acquisition device 8 corresponds with the position of the point of intersection of the two arms of the cross.

[0068] In accordance with the preferred embodiment, indicated in the enclosed figures 1-4, the apparatus 1 comprises at least two markers 9, preferably applied outside the work area L of each embroidering head 4 at two opposite corners thereof.

[0069] In accordance with the aforesaid preferred embodiment, the image acquisition device 8 is configured for detecting the position of the two markers 9 in the first and second time instant t1, t2 and the electronic calibration unit 400 is configured for comparing the positions of the two markers 9 (in particular by means of the comparison module 400') and for determining the position variation by separating it into a translation and a rotation with respect to the reference (in particular by means of the calculation module 400"). Advantageously, both the translation and the rotation can be determined by taking as reference the Cartesian plane associated with the work surface 2, and preferably they are determined with respect to the point of origin O.

[0070] Advantageously, the image acquisition device 8 is provided with a reading area of reduced size with respect to the work surface 3, and preferably reduced with respect to the work area L of each embroidering head 4, e.g. on the order of 10x10 cm. Advantageously, a reading area thus reduced allows obtaining the position of each marker 9 with extreme precision. Indeed, in operation, the position of each marker 9 is obtained by associating each pixel of the reading area with the value of the actual corresponding area of the sheet-like medium S, expressed in square millimeters (or multiples thereof or submultiples thereof). Hence, the smaller the reading area of the image acquisition device 8 and the smaller the actual area of the sheet-like medium S associated with each pixel, consequently the greater the precision of identification of the position of the marker 9.

[0071] For example, a camera provided with a resolution of 16 megapixels (equal to the normal cameras widespread on the market) which frames an area of 10000 mm^2 (equivalent to 10x10 cm) allows associating with each pixel an actual area equal to 0.000625 mm^2, i.e. a square with 0.025 mm side (the calculation was executed by simply dividing the area in square millimeters by the number of pixels = 10000 mm^2 / ($16*10^6$ pixels) = 0.000625 mm^2/pixel).

[0072] In operation, therefore, the image processing means of the image acquisition device 8 determine the position of the marker 9 by identifying its position (expressed in pixels) on the reading area of the camera, and subsequently they transform such position into a Carte-

sian coordinate. Finally, they obtain the actual position of the marker 9 on the Cartesian plane associated with the work surface 3 by means of the vector sum of the position of the image acquisition device 8 on the work surface 3 and of the position of the marker 9 on the reading area.

[0073] Functionally, the image acquisition device 8 is configured for recognizing the marker 9 on the basis of several guide lines assigned thereto, e.g. a yellow circle with a black cross at its interior. Advantageously, in order to speed up the identification of the position of each marker 9, the image acquisition device 8 is movable along the work surface 3 by the third movement means 30 in order to acquire the position of each marker 9 in succession. In other words, in order to acquire the position of only one marker 9 at a time.

[0074] In the enclosed figures 2-4, the work area L of an embroidering head 4 is represented, at whose interior a figure F was embroidered and two markers 9 were applied outside the work area L, at two opposite corners thereof.

[0075] Moreover, in the enclosed figures 2-4, in addition to the actually embroidered figure F (indicated with solid line), also the theoretical figure to be embroidered F' is represented (indicated with dashed line) as set in the embroidery program of the first electronic control unit 100. Advantageously, such figures allow perceiving the position variation that the embroidered figure F can sustain, with respect to the theoretical figure to be embroidered F'.

[0076] In the same manner, in the enclosed figures 2-4 the two markers 9 are represented with a dashed line in the first time instant t1 before the execution of the embroidery, and the two markers 9 are represented with a solid line in the second time instant t2 after the execution of the embroidery.

[0077] It is then possible to see that the position variation sustained by the markers 9 between the two time instants corresponds with the position variation sustained by the embroidered figure F, with respect to the theoretical figure to be embroidered F'.

[0078] Also forming the object of the present invention is a process for calibrating an apparatus for making decorations on at least one sheet-like medium of the above-described type and regarding which, for the sake of description simplicity, the same reference nomenclature will be employed hereinbelow.

[0079] The process according to the invention comprises a step of arranging at least one sheet-like medium S on the work surface 3. Advantageously, on the work surface 3, multiple sheet-like media S can be arranged that are side-by-side (each at a different embroidering head 4) or at least partially overlapped (in order to be sewn together), and such sheet-like media S are fixed to the work surface 3 in a per se known manner. Advantageously, a step can be provided of initial calibration between the position of the embroidering head 4 and the laser cutting head 6, of per se known type. More in detail, the initial calibration provides that each embroidering head 4 executes a series of blank stitches (i.e. without the use of the thread) on the sheet-like medium S and that the laser cutting head 6 projects a series of laser beams on the sheet-like medium S itself at the blank stitches. If the laser beams projected by the laser cutting head 6 do not coincide with the blank stitches made by each embroidering head 4, the initial calibration provides that an operator will manually calibrate the second movement means 20 until each laser beam is superimposed on the corresponding blank stitch.

[0080] Advantageously, the positions of the blank stitches and of the laser beams are defined by means of a series of relative Cartesian coordinates taken with reference to the Cartesian plane associated with the work surface 3.

[0081] According to the idea underlying the present invention, the calibration process, object of the present invention, comprises a step of applying at least one marker 9 on the sheet-like medium S. Preferably, each marker 9 is applied outside the work area L of each embroidering head 4 so as to not obstruct the embroidery work thereof.

[0082] Of course, if, on the work surface 3, multiple sheet-like media S have been arranged overlapped, it is sufficient to apply each marker 9 on the sheet-like medium S arranged on top of the others, such that the marker 9 is easily identifiable.

[0083] A first step is then provided for acquiring the position of each marker 9, in which the image acquisition device 8 is moved along the work surface 3 in order to detect the position of each marker 9 in the first time instant t1 with respect to the selected reference, e.g. with respect to the Cartesian plane associated with the work surface 3. A step then follows for storing, by the electronic calibration unit 400, the position of the marker 9 acquired in the first time instant t1.

[0084] Then, one proceeds with a step of embroidery of the figure F on the sheet-like medium S by means of the embroidering head 4.

[0085] A second step is then provided for acquiring the position of each marker 9, in which the image acquisition device 8 is moved along the work surface 3 in order to detect the position of each marker 9 in the second time instant t2 with respect to the same reference selected in the first acquisition step.

[0086] A step then follows for comparing, by the electronic calibration unit 400, the position of the marker 9 acquired in the second time instant t2 with the position acquired in the first time instant t1, and determining the position variation sustained by the marker 9 during the embroidery step with respect to the same reference.

[0087] Advantageously, in the first and second acquisition step, the positions of the marker 9 in the first and second time instant t1, t2 are acquired in the form of Cartesian coordinates taken starting from the point of origin O of the Cartesian plane associated with the work surface 3. Advantageously, therefore, also the position variation is determined with respect to the reference of

the Cartesian plane, and more precisely with respect to the point of origin O of the Cartesian plane.

[0088] The calibration process, object of the present invention, subsequently provides for a step of automatic calibration of the laser cutting head 6 by means of the actuation of the second movement means 20 in order to calibrate the laser cutting head 6 on the basis of the position variation determined in the comparison step.

[0089] More in detail, in the step of automatic calibration, the electronic calibration unit 400 communicates to the second electronic control unit 200 the position variation determined in the comparison step and the second electronic control unit 200 modifies the cutting program consistent with the received position variation and obtains a new theoretical figure to be cut that is defined with respect to the Cartesian plane associated with the work surface 3, and such theoretical figure to be cut traces the actually embroidered figure F.

[0090] The process according to the invention then provides for a step of laser cutting by means of the laser cutting head 6 at least of one edge of the figure F embroidered on the sheet-like medium S in the embroidery step.

[0091] Advantageously, in the latter step, the laser cutting head 6 executes the cutting on the basis of the cutting program modified by the second electronic control unit 200 consistent with the position variation determined in the step of automatic calibration. Advantageously, the calibration process can provide for, in the application step, applying two markers 9, preferably outside the work area L of each embroidering head 4, at two opposite corners thereof.

[0092] In this case, during the comparison step, the variation of position of the two markers 9 is determined by separating it into a translation and a rotation with respect to the selected reference. In other words, with respect to the Cartesian plane associated with the work surface 3 and preferably with respect to its point of origin O.

[0093] In the step of automatic calibration, therefore, the second electronic control unit 200 modifies the cutting program consistent with the translation and the rotation received from the electronic calibration unit 400.

[0094] Advantageously, the above-described calibration process allows interposing, between the embroidery step and the second step of acquiring the position of the marker 9, further working steps, such as a second embroidery step or a step of printing the embroidered sheet-like medium S. Such further working steps can also comprise a step of removal of the sheet-like medium S from the work surface 3 (e.g. in order to execute the printing step) and a subsequent second step of arranging the sheet-like medium S on the work surface 3.

[0095] In this case, the second step of acquiring the position of the marker 9 advantageously allows not being affected by the inevitable differences of position taken by the figure F with respect to the Cartesian reference plane after the second arranging step, and allows correctly executing the cutting of the embroidered figure F.

[0096] The apparatus 1 and the process thus conceived therefore attain the pre-established objects.

[0097] In particular, the above-described apparatus and process allow avoiding a periodic calibration of conventional type (i.e. the calibration attained by mating the blank stitches obtained by the embroidering head 4 with the laser beams projected by the laser cutting head 6) of the first and second movement means 10, 20. This because such periodic calibration of conventional type is advantageously substituted by the calibration process and by the apparatus 1, object of the present invention.

[0098] In addition, the step of initial calibration between the position of the embroidering head 4 and the laser cutting head 6 can be advantageously carried out with different modes. For example, without having to make a reference mark with the embroidering head 4 (i.e. the blank stitches of the calibration of conventional type), it is possible to employ a first reference manually reported on the fabric or even constituted by the same above-indicated marker 9 and then a second reference made by the laser head so as to detect the distance between the two references before then calibrating the laser cutting head 6 on the basis of this distance.

[0099] A further calibration of the laser cutting head 6, which accounts for the distortion in the sheet-like medium S introduced by the embroidery step, is then carried out after each embroidery step due to the calibration process and the apparatus 1, object of the present invention.

Claims

1. Apparatus (1) for making decorations on at least one sheet-like medium, which comprises:

- a support structure (2);
- at least one work surface (3), substantially horizontal, fixed to said support structure (2) and on which at least one sheet-like medium (S) to be embroidered and cut is adapted to be positioned;
- at least one embroidering head (4) adapted to embroider at least one figure (F) on a work area (L) of said sheet-like medium (S), mounted on said support structure (2) and actuatable to be moved with respect to said work surface (3) by means of first movement means (10);
- at least one laser cutting head (6), adapted to cut said at least one sheet-like medium (S) along at least one border of said figure (F), mounted on said support structure (2) and actuatable to be moved with respect to said work surface (3) by means of second movement means (20);
- at least one image acquisition device (8) mounted on said support structure (2), directed towards said work surface (3), actuatable to be moved with respect to the latter by means of

third movement means (30) and configured for detecting the position of at least one marker (9) applied on said sheet-like medium (S);
- an electronic calibration unit (400) connected to said image acquisition device (8) and to said laser cutting head (6), and such electronic calibration unit (400) is capable of actuating said second movement means (20) in order to position said laser cutting head (6) on said sheet-like medium (S); said apparatus (1) being **characterized in that** said image acquisition device (8) is configured for detecting the position of said at least one marker (9) applied on said sheet-like medium (S) in at least:
- a first time instant (t1), before the execution of the embroidery of said figure (F) by said embroidering head (4), and
- a second time instant (t2), after the execution of the embroidery of said figure (F) by said embroidering head (4);

said electronic calibration unit (400) being configured for comparing the positions of said at least one marker (9) acquired in said first and second time instant (t1, t2), determining the position variation undergone by said at least one marker (9) between said first and second time instants (t1, t2) with respect to a reference on said work surface (3); and being configured for driving said second movement means (20) to move said laser cutting head (6), collimating it with the position of said figure (F) embroidered by said embroidering head (4), obtained from said position variation of said at least one marker (9) with respect to said reference.

2. Apparatus (1) for making decorations on at least one sheet-like medium according to claim 1, **characterized in that** said at least one marker (9) is applied on said sheet-like medium (S) outside the work area (L) of each embroidering head (4).

3. Apparatus (1) for making decorations on at least one sheet-like medium according to claim 1, **characterized in that** said at least one marker (9) is an adhesive element.

4. Apparatus (1) for making decorations on at least one sheet-like medium according to claim 1, **characterized in that** said at least one marker (9) is colored with a color contrasting with the color of said sheet-like medium (S) on which it is applied, in order to be easily detected by said image acquisition device (8).

5. Apparatus (1) for making decorations on at least one sheet-like medium according to any one of the preceding claims, **characterized in that** it comprises at least two markers (9), preferably applied outside the work area (L) of each embroidering head (4) at two opposite corners thereof;

wherein said image acquisition device (8) is configured for detecting the position of said two markers (9) in said first and second time instant (t1, t2);
wherein said electronic calibration unit (400) is configured for comparing the positions of said two markers (9), determining said position variation of said two markers (9) by separating it into a translation and a rotation with respect to said reference.

6. Apparatus (1) for making decorations on at least one sheet-like medium according to claim 1, **characterized in that** said image acquisition device (8) is provided with a reading area of reduced size with respect to said work surface (3).

7. Apparatus (1) for making decorations on at least one sheet-like medium according to claim 6, **characterized in that** the reading area for said image acquisition device (8) has dimensions on the order of 10x10 cm.

8. Apparatus (1) for making decorations on at least one sheet-like medium according to claim 1, **characterized in that** said image acquisition device (8) is movable along said work surface (3) by said third movement means (30) in order to acquire the position of each marker (9) in succession.

9. Process for calibrating an apparatus (1) for making decorations on at least one sheet-like medium according to claim 1, comprising the following operating steps:

- a step of arranging said at least one sheet-like medium (S) on said work surface (3);
- a step of applying said at least one marker (9) on said sheet-like medium (S);

said calibrating process being **characterized in that** it also comprises the following operating steps:

- a first step of acquiring the position of said at least one marker (9) in which said image acquisition device (8) is moved along said work surface (3) in order to detect the position of said at least one marker (9) in said first time instant (t1) with respect to said reference;
- a step of storing, by said electronic calibration unit (400), the position of said at least one marker (9) acquired in said first time instant (t1);
- a step of embroidery of said figure (F) on said at least one sheet-like medium (S) by means of said embroidering head (4);
- a second step of acquiring the position of said

at least one marker (9) in which said image acquisition device (8) is moved along said work surface (3) in order to detect the position of said at least one marker (9) in said second time instant (t2) with respect to said reference;
- a step of comparing, by said electronic calibration unit (400), the position of said at least one marker (9) acquired in said second time instant (t2) with the position acquired in said first time instant (t1) and determining the position variation sustained by said at least one marker (9) during said embroidering step with respect to said reference;
- a step of automatic calibration of said laser cutting head (6) by means of actuation of said second movement means (20) in order to calibrate said laser cutting head (6) on the basis of said position variation determined in said comparison step;
- a step of laser cutting by means of said laser cutting head (6) at least of one edge of said figure (F) embroidered on said sheet-like medium (S) in said embroidering step.

10. Process for calibrating an apparatus (1) for making decorations on at least one sheet-like medium according to claim 9 **characterized in that**:

- two markers (9) are applied in said application step;
- in said comparison step, said variation of position of said two markers (9) is determined by separating it into a translation and a rotation with respect to said reference;
- in said automatic calibration step, said second movement means (20) move said laser cutting head (6) on the basis at least of said rotation calculated in said comparison step.

Patentansprüche

1. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium, die Folgendes umfasst:

- eine tragende Struktur (2);
- mindestens eine Arbeitsfläche (3), im Wesentlichen horizontal, die an der genannten tragenden Struktur (2) befestigt ist und auf der mindestens ein zu bestickendes und zu gravierendes blattmäßiges Medium (S) geeignet ist, positioniert zu werden;
- mindestens einen Stickkopf (4), der geeignet ist, mindestens eine Figur (F) auf einen Arbeitsbereich (L) des genannten blattmäßigen Mediums (S) zu sticken, der auf der genannten tragenden Struktur (2) montiert ist und betätigt werden kann, um sich im Verhältnis zu der genannten Arbeitsfläche (3) mittels erster Bewegungsmittel (10) zu verschieben;
- mindestens einen Lasergravierkopf (6), der geeignet ist, das genannte blattmäßige Medium (S) entlang mindestens einer Kontur der genannten Figur (F) zu gravieren, der auf der genannten tragenden Struktur (2) montiert ist und betätigt werden kann, um sich im Verhältnis zu der genannten Arbeitsfläche (3) mittels zweiter Bewegungsmittel (20) zu verschieben;
- mindestens eine Bilderfassungsvorrichtung (8), die auf der genannten tragenden Struktur (2) montiert und zu der genannten Arbeitsfläche (3) gerichtet ist sowie betätigt werden kann, um sich im Verhältnis zu letzterer mittels dritter Bewegungsmittel (30) zu verschieben, und darauf ausgelegt ist, die Position mindestens eines auf dem genannten blattmäßigen Medium (S) angebrachten Markers (9) zu erfassen;
- ein elektronisches Kalibriergerät (400), das an die genannte Bilderfassungsvorrichtung (8) und an den genannten Lasergravierkopf (6) angeschlossen ist, wobei dieses elektronische Kalibriergerät (400) in der Lage ist, die genannten zweiten Bewegungsmittel (20) zu betätigen, um den genannten Lasergravierkopf (6) auf dem genannten blattmäßigen Medium (S) zu positionieren;

wobei die genannte Vorrichtung (1) **dadurch gekennzeichnet ist, dass** die genannte Bilderfassungsvorrichtung (8) darauf ausgelegt ist, die Position des genannten mindestens einen, auf dem genannten blattmäßigen Medium (S) angebrachten Markers (9) mindestens wie folgt zu erfassen:

- in einem ersten Moment (t1), der der Ausführung des Stickens der genannten Figur (F) von Seiten des genannten Stickkopfes (4) vorausgeht, und
- in einem zweiten Moment (t1), im Anschluss an die Ausführung des Stickens der genannten Figur (F) von Seiten des genannten Stickkopfes (4);

wobei das genannte elektronische Kalibriergerät (400) darauf ausgelegt ist, die in dem genannten ersten und zweiten Moment (t1, t2) erfassten Positionen des genannten mindestens einen Markers (9) miteinander zu vergleichen und so die Positionsänderung zu bestimmen, von der der genannte Marker (t1, t2) zwischen dem genannten ersten und zweiten Moment (t1, t2) im Verhältnis zu einem Bezug auf der genannten Arbeitsfläche (3) betroffen war; und wobei sie darauf ausgelegt ist, die genannten zweiten Bewegungsmittel (20) anzusteuern, damit diese den genannten Lasergravierkopf (6) verschieben

und ihn so mit der Position der von dem genannten Stickkopf (4) gestickten genannten Figur (F) in Übereinstimmung zu bringen, die ausgehend von der genannten Positionsveränderung des genannten mindestens einen Markers (9) im Verhältnis zu dem genannten Bezug erreicht wurde.

2. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 1, **dadurch gekennzeichnet, dass** der genannte mindestens eine Marker (9) auf dem genannten blattmäßigen Medium (S) außerhalb des Arbeitsbereichs (L) jedes Stickkopfes (4) angebracht ist.

3. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 1, **dadurch gekennzeichnet, dass** der genannte mindestens eine Marker (9) ein Klebeelement ist.

4. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 1, **dadurch gekennzeichnet, dass** der genannte mindestens eine Marker (9) in einer Kontrastfarbe zu der Farbe des genannten blattmäßigen Mediums (S), auf dem er angebracht wird, gefärbt ist, um von der genannten Bilderfassungsvorrichtung (8) leicht erfasst zu werden.

5. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach irgendeinem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, dass** sie mindestens zwei Marker (9) umfasst, die vorzugsweise außerhalb des Arbeitsbereichs (L) jedes Stickkopfes (4) an zwei gegenüberliegenden Ecken des Bereichs angebracht sind;

wobei die genannte Bilderfassungsvorrichtung (8) darauf ausgelegt ist, die Position der genannten beiden Marker (9) in dem genannten ersten und zweiten Moment (t1, t2) zu erfassen;
wobei das genannte elektronische Kalibriergerät (400) darauf ausgelegt ist, die Positionen der genannten beiden Marker (9) zu vergleichen und die genannte Positionsänderung der genannten beiden Marker (9) zu bestimmen, indem sie in eine Verschiebung und eine Drehung im Verhältnis zu dem genannten Bezug unterteilt wird.

6. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 1, **dadurch gekennzeichnet, dass** die genannte Bilderfassungsvorrichtung (8) mit einem im Verhältnis zu dem genannten Arbeitsbereich (3) kleineren Ablesebereich ausgestattet ist.

7. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 6, **dadurch gekennzeichnet, dass** der Ablesebereich der genannten Bilderfassungsvorrichtung (8) Abmessungen der Größenordnung von 10 x 10 cm aufweist.

8. Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 1, **dadurch gekennzeichnet, dass** die genannte Bilderfassungsvorrichtung (8) entlang der genannten Arbeitsfläche (3) von den genannten dritten Bewegungsmitteln (30) bewegt werden kann, um der Reihe nach die Position jedes Markers (9) zu erfassen.

9. Verfahren zur Kalibrierung einer Vorrichtung (1) zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 1, das die folgenden Arbeitsschritte umfasst:

- einen Schritt der Vorbereitung des genannten mindestens einen blattmäßigen Mediums (S) auf der genannten Arbeitsfläche (3);
- einen Schritt des Anbringens des genannten mindestens einen Markers (9) auf dem genannten blattmäßigen Medium (S);

wobei das Verfahren zur Kalibrierung **dadurch gekennzeichnet ist, dass** es außerdem die folgenden Arbeitsschritte umfasst:

- einen ersten Schritt des Erfassens der Position des genannten mindestens einen Markers (9), bei dem die genannte Bilderfassungsvorrichtung (8) entlang der genannten Arbeitsfläche (3) bewegt wird, um die Position des genannten mindestens einen Markers (9) in dem genannten ersten Moment (t1) im Verhältnis zu dem genannten Bezug zu erfassen;
- einen Schritt der Speicherung von Seiten des genannten elektronischen Kalibriergeräts (400) der in dem genannten ersten Moment (t1) erfassten Position des genannten mindestens einen Markers (9);
- einen Schritt des Stickens der genannten Figur (F) auf dem genannten mindestens einen blattmäßigen Medium (S) mittels des genannten Stickkopfes (4);
- einen zweiten Schritt des Erfassens der Position des genannten mindestens einen Markers (9), bei dem die genannte Bilderfassungsvorrichtung (8) entlang der genannten Arbeitsfläche (3) bewegt wird, um die Position des genannten mindestens einen Markers (9) in dem genannten zweiten Moment (t1) im Verhältnis zu dem genannten Bezug zu erfassen;
- einen Schritt des Vergleichens von Seiten des

genannten elektronischen Kalibriergeräts (400) der in dem genannten zweiten Moment (t2) erfassten Position des genannten mindestens einen Markers (9) mit der in dem genannten ersten Moment (t1) erfassten Position und des Bestimmens der Positionsänderung, von der der genannte mindestens eine Marker (9) während des genannten Schritts des Stickens im Verhältnis zu dem genannten Bezug betroffen war;
- einen Schritt der automatischen Kalibrierung des genannten Lasergravierkopfes (6) mittels Betätigung der genannten zweiten Bewegungsmittel (20), um den genannten Lasergravierkopf (6) auf Grundlage der bei dem genannten Schritt des Vergleichens bestimmten genannten Positionsänderung zu kalibrieren;
- einen Schritt des Lasergravierens mittels des genannten Lasergravierkopfes (6) mindestens eines Randes der bei dem genannten Schritt des Stickens auf das genannte blattmäßige Medium (S) gestickten genannten Figur (F).

10. Verfahren zur Kalibrierung einer Vorrichtung zur Herstellung von Dekorationen auf mindestens einem blattmäßigen Medium nach Anspruch 9, **dadurch gekennzeichnet, dass**:

- bei dem genannten Anbringungsschritt zwei Marker (9) angebracht werden;
- bei dem genannten Schritt des Vergleichens die genannte Positionsänderung der genannten beiden Marker (9) durch Unterteilen derselben in eine Verschiebung und eine Drehung im Verhältnis zu dem genannten Bezug bestimmt wird;
- bei dem genannten Schritt der automatischen Kalibrierung die genannten zweiten Bewegungsmittel (20) den genannten Lasergravierkopf (6) auf Grundlage mindestens der bei dem genannten Schritt des Vergleichens berechneten genannten Drehung verschieben.

Revendications

1. Appareil (1) permettant de décorer sur au moins un support en feuille, qui comprend :

- une structure de support (2) ;
- au moins une surface d'usinage (3), sensiblement horizontale, fixée à ladite structure de support (2) et sur laquelle au moins un support en feuille (S) à broder et graver est apte à être placé ;
- au moins une tête brodeuse (4) apte à broder le long d'un profil (F) sur une zone de travail (L) dudit support en feuille (S), montée sur ladite structure de support (2) et actionnable pour être déplacée par rapport à ladite surface d'usinage (3) par l'intermédiaire de premiers moyens de mouvement (10) ;
- au moins une tête de découpe laser (6), apte à découper ledit au moins un support en feuille (S) le long d'au moins un contour dudit profil (F), montée sur ladite structure de support (2) et actionnable pour être déplacée par rapport à ladite surface d'usinage (3) par l'intermédiaire de deuxièmes moyens de mouvement (20) ;
- au moins un dispositif de saisie d'images (8) monté sur ladite structure de support (2), orienté vers ladite surface d'usinage (3), actionnable pour être déplacé par rapport à celle-ci par l'intermédiaire de troisièmes moyens de mouvement (30) et configuré pour détecter la position d'au moins un marqueur (9) appliqué sur ledit support en feuille (S) ;
- une unité d'étalonnage électronique (400) reliée audit dispositif de saisie d'images (8) et à ladite tête de découpe laser (6), laquelle unité d'étalonnage électronique (400) est capable d'actionner lesdits deuxièmes moyens de mouvement (20) pour positionner ladite tête de découpe laser (6) sur ledit support en feuille (S) ;

ledit appareil (1) étant **caractérisé en ce que** ledit dispositif de saisie d'images (8) est configuré pour détecter la position dudit au moins un marqueur (9) appliqué sur ledit support en feuille (S) dans au moins :

- un premier laps de temps (t1), avant la réalisation de la broderie dudit profil (F) de la part de ladite tête brodeuse (4), et
- un second laps de temps (t2), après la réalisation de la broderie dudit profil (F) de la part de ladite tête brodeuse (4) ;

ladite unité d'étalonnage électronique (400) étant configurée pour comparer les positions dudit au moins un marqueur (9) acquises dans lesdits premier et second laps de temps (t1, t2), en déterminant le changement de position subi par ledit au moins un marqueur (9) entre lesdits premier et second laps de temps (t1, t2) par rapport à un point de repère sur ladite surface d'usinage (3) ; et étant configurée pour contrôler lesdits deuxièmes moyens de mouvement (20) afin de déplacer ladite tête de découpe laser (6) en correspondance avec la position dudit profil (F) brodé par ladite tête brodeuse (4), obtenue à partir dudit changement de position dudit au moins un marqueur (9) par rapport audit point de repère.

2. Appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 1, **caractérisé en ce que** ledit au moins un marqueur (9) est appliqué sur ledit support en feuille (S) à l'extérieur de la zone de travail (L) de chaque tête brodeuse (4).

3. Appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 1, **caractérisé en ce que** ledit au moins un marqueur (9) est un élément adhésif.

4. Appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 1, **caractérisé en ce que** ledit au moins un marqueur (9) est coloré avec une couleur en contraste avec la couleur dudit support en feuille (S) sur lequel il est appliqué, pour être facilement détecté par ledit dispositif de saisie d'images (8).

5. Appareil (1) permettant de décorer sur au moins un support en feuille selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il comprend au moins deux marqueurs (9), de préférence appliqués à l'extérieur de la zone de travail (L) de chaque tête brodeuse (4) au niveau de deux angles opposés de celles-ci ;

où ledit dispositif de saisie d'images (8) est configuré pour détecter la position desdits deux marqueurs (9) dans lesdits premier et second laps de temps (t1, t2) ;
où ladite unité d'étalonnage électronique (400) est configurée pour comparer les positions desdits deux marqueurs (9) en déterminant ledit changement de position desdits deux marqueurs (9) en le transformant en une translation et une rotation par rapport audit point de repère.

6. Appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 1, **caractérisé en ce que** ledit dispositif de saisie d'images (8) est doté d'une zone de lecture de petite taille par rapport à ladite surface d'usinage (3).

7. Appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 6, **caractérisé en ce que** la zone de lecture dudit dispositif de saisie d'images (8) a une taille de l'ordre de 10×10 cm.

8. Appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 1, **caractérisé en ce que** ledit dispositif de saisie d'images (8) est déplaçable le long de ladite surface d'usinage (3) par l'intermédiaire desdits troisièmes moyens de mouvement (30) pour acquérir en succession la position de chaque marqueur (9).

9. Procédé d'étalonnage d'un appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 1, comprenant les étapes opérationnelles suivantes :

- une étape de pré-emplacement dudit au moins un support en feuille (S) sur ladite surface d'usinage (3) ;
- une étape d'application dudit au moins un marqueur (9) sur ledit support en feuille (S) ;

ledit procédé d'étalonnage étant **caractérisé en ce qu'**il comprend en outre les étapes opérationnelles suivantes :

- une première étape d'acquisition de la position dudit au moins un marqueur (9) où ledit dispositif de saisie d'images (8) est déplacé le long de ladite surface d'usinage (3) pour détecter la position dudit au moins un marqueur (9) dans ledit premier laps de temps (t1) par rapport audit point de repère ;
- une étape de mémorisation de la part de ladite unité d'étalonnage électronique (400) de la position dudit au moins un marqueur (9) acquise dans ledit premier laps de temps (t1) ;
- une étape de broderie dudit profil (F) sur au moins un support en feuille (S) au moyen de ladite tête brodeuse (4) ;
- une seconde étape d'acquisition de la position dudit au moins un marqueur (9) où ledit dispositif de saisie d'images (8) est déplacé le long de ladite surface d'usinage (3) pour détecter la position dudit au moins un marqueur (9) dans ledit second laps de temps (t2) par rapport audit point de repère ;
- une étape de comparaison réalisée par ladite unité d'étalonnage électronique (400) de la position dudit au moins un marqueur (9) acquise dans ledit second laps de temps (t2) avec la position acquise dans ledit premier laps de temps (t1) et détermination du changement de position subi par ledit au moins un marqueur (9) pendant ladite étape de broderie par rapport audit point de repère ;
- une étape d'étalonnage automatique de ladite tête de découpe laser (6) par l'actionnement desdits deuxièmes moyens de mouvement (20) pour calibrer ladite tête de découpe laser (6) en fonction dudit changement de position déterminé dans ladite étape de comparaison ;
- une étape de découpe laser au moyen de ladite tête de découpe laser (6) d'un bord dudit profil (F) brodé sur ledit support en feuille (S) dans ladite étape de broderie.

10. Procédé d'étalonnage d'un appareil (1) permettant de décorer sur au moins un support en feuille selon la revendication 9, **caractérisé en ce que** :

- dans ladite étape d'application deux marqueurs (9) sont appliqués ;
- dans ladite étape de comparaison, ledit changement de position desdits deux marqueurs (9)

est déterminé en le transformant en une translation et une rotation par rapport audit point de repère ;

- dans ladite étape d'étalonnage automatique lesdits deuxièmes moyens de mouvement (20) déplacent ladite tête de découpe laser (6) en fonction d'au moins ladite rotation calculée dans ladite étape de comparaison.

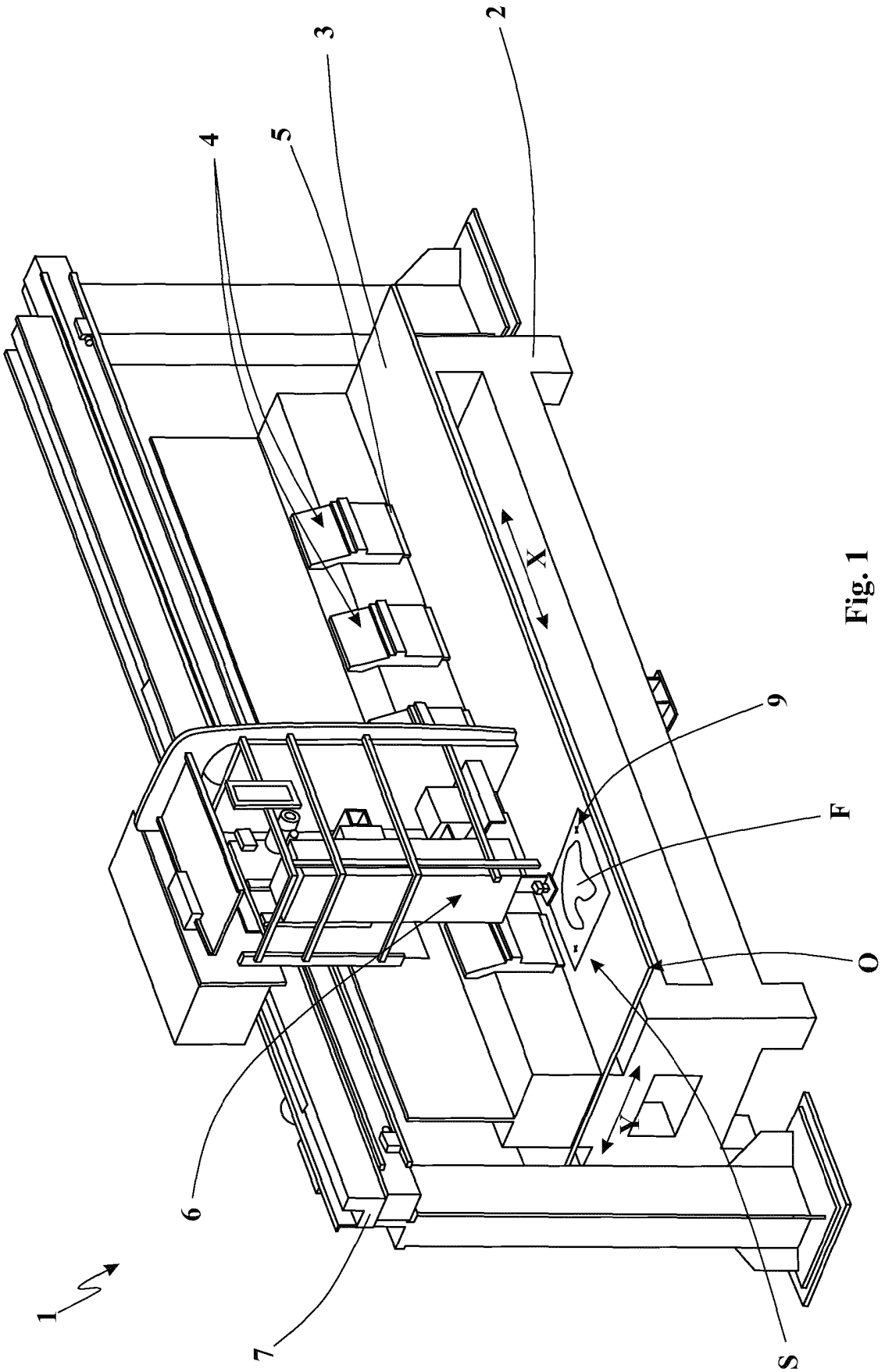

Fig. 1

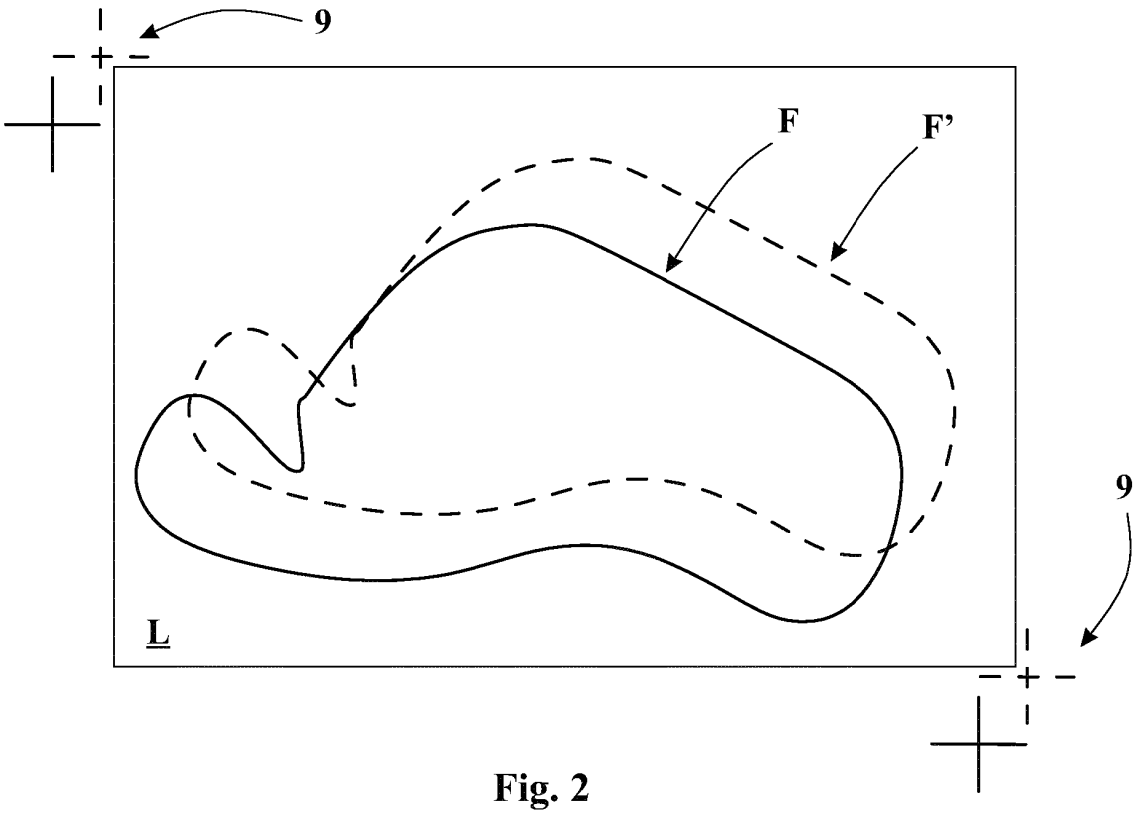

Fig. 2

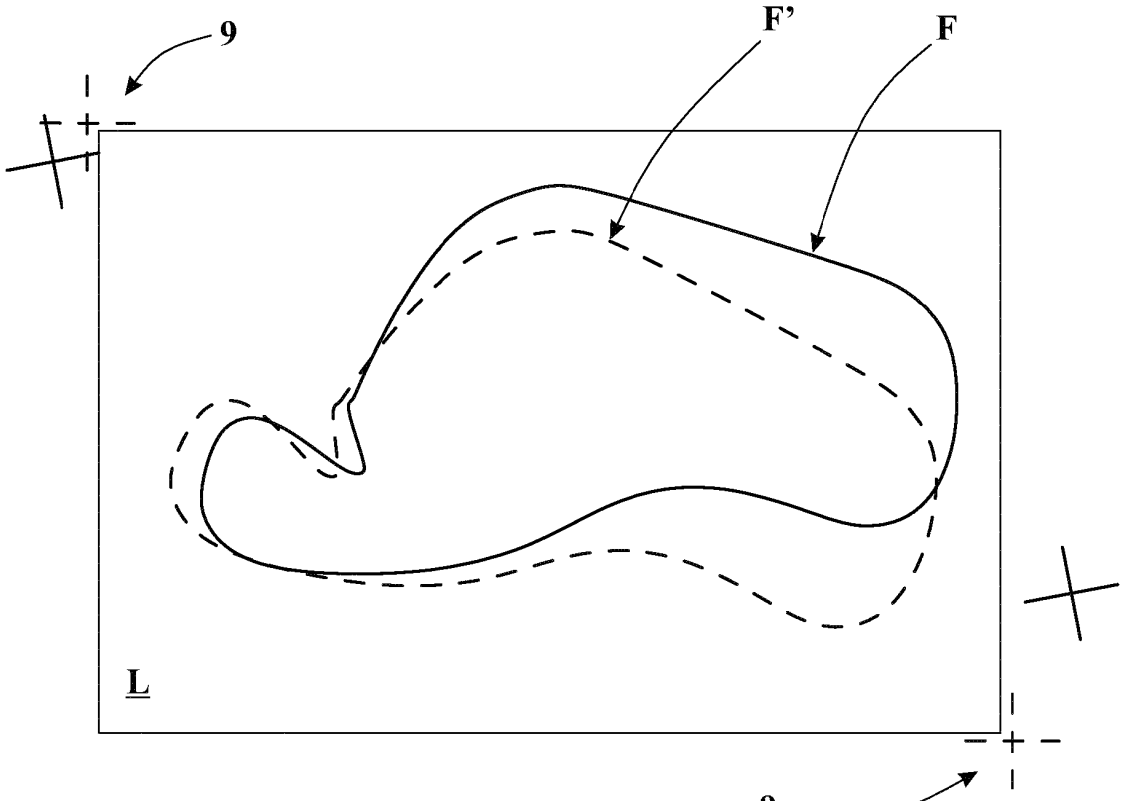

Fig. 3

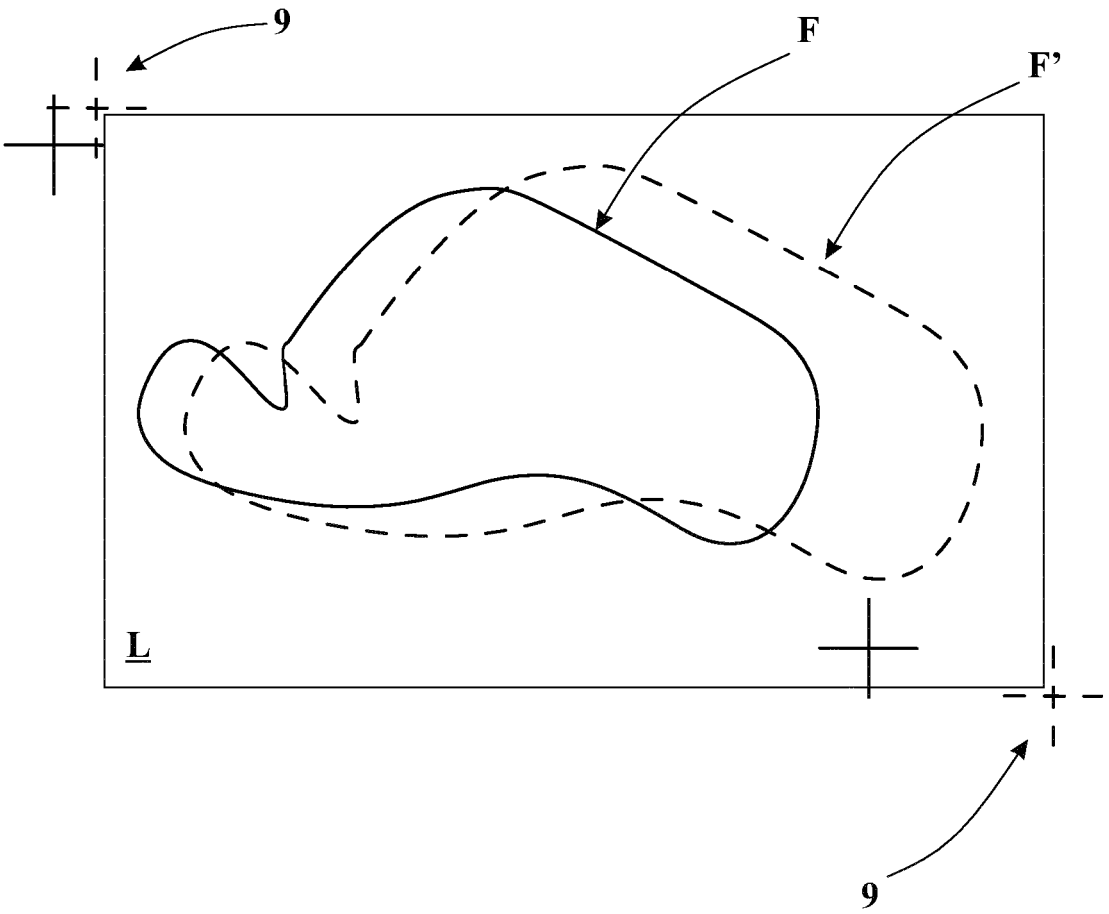

Fig. 4

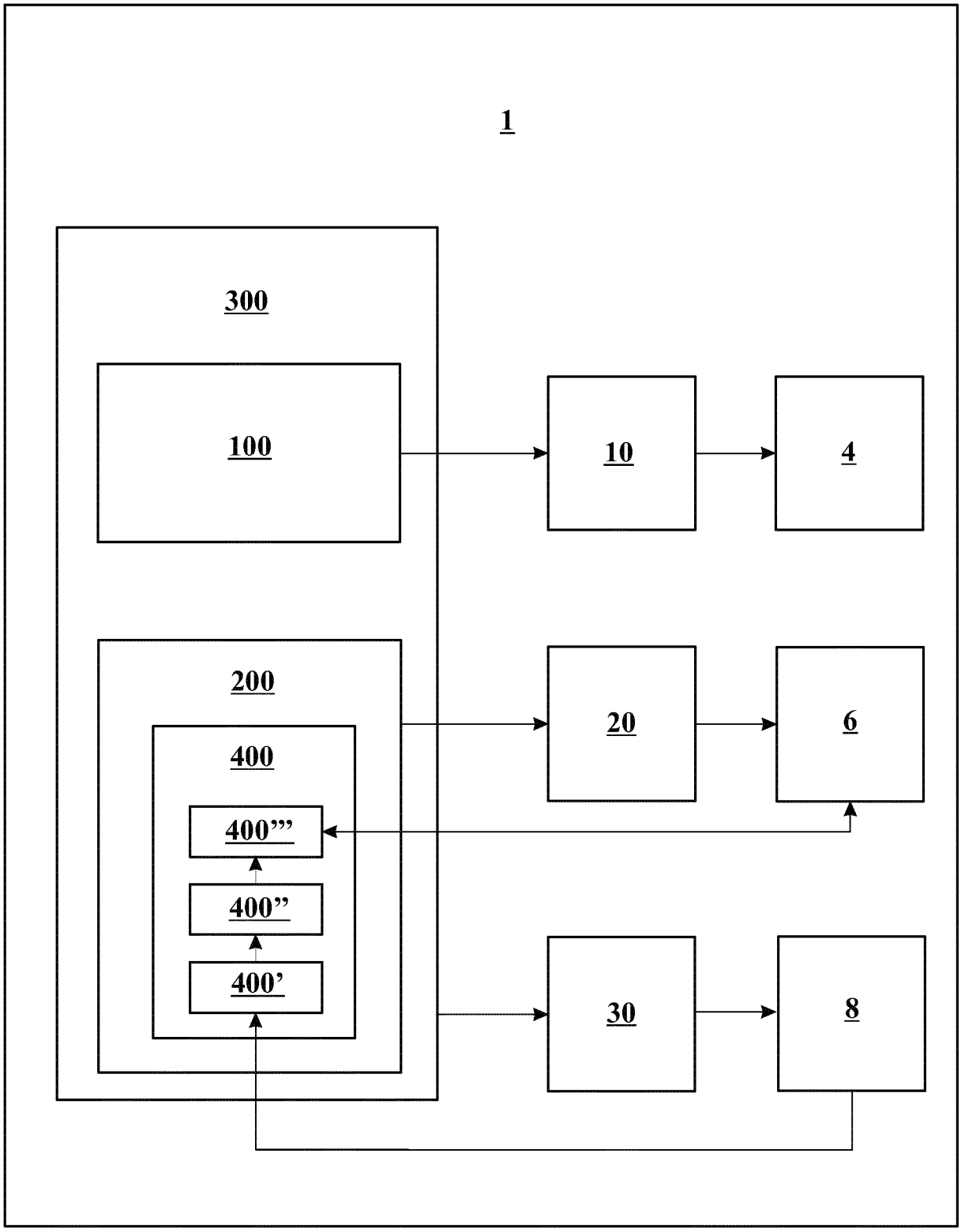

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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