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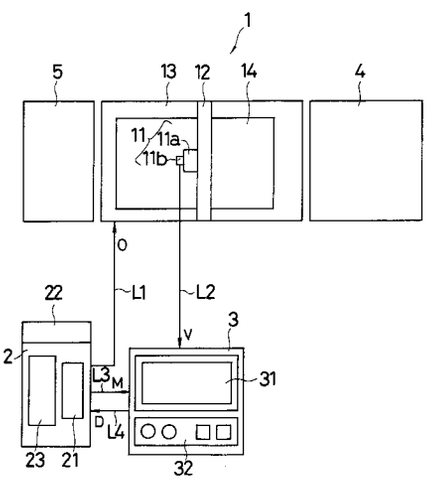
(54) PATTERN MATCHING METHOD AND APPARATUS FOR AUTOMATIC CUTTING MACHINES.

(57) A pattern matching method and a pattern matching apparatus for automatic cutting machines, which are used to easily carry out the automatic marking and cutting of a pattern-carrying sheet material, such as a part of clothes. A sheet material (14) is spread and fixed on a table (13) of a cutting apparatus (1). A camera (11b) is two-dimensionally movable above the sheet material (14). A signal V of an image taken by the camera (11b) is applied to a deflection controller (3) through a line (L2), and displayed on a monitor (31). The monitor (31) displays a reference mark, which is superposed on an image of a pattern, by reference to reference marking data M sent from a marking unit (2) thereto through a line (L3). When a deflection regulator (32) of the deflection controller (3) is operated, deflection data D are supplied to the marking unit (2) through a line (L4), and a head moving signal (O) is sent therefrom to the cutting apparatus (1) through a line (L1) to move the head (11). When the reference mark agrees with the characteristic point set on the pattern in advance, the pattern matching operation finishes, and the pattern data are corrected by an amount of deflection by the marking unit (2).

Fig. 1



EP 0 577 842 A1

Technical Field

The present invention relates to a pattern matching method and apparatus for an automatic cutting machine which automatically marks and cuts a sheet-type material such as a patterned fabric.

Background Art

The manufacturing of clothing or like products out of a woven or knitted fabric involves a cutting process in which individual parts such as fronts, backs, and sleeves are cut out of the fabric. In the cutting process, uses an automatic cutting apparatus is used for automatically cutting a single sheet or a plurality of sheets of material such as fabric, which are stacked in layers on a flat table. The layout of the parts to be cut with the automatic cutting apparatus is adjusted by a marking operation which aims at obtaining the maximum number of parts from the sheet-type material by minimizing the remaining portion thereof after cutting. When the marking operation is performed manually, clothing patterns in the shapes of individual parts are used. It is also possible to automatically perform the marking operation by means of an automatic marking apparatus without using such clothing patterns.

In manufacturing clothing or like products out of a sheet-type material with a design, such as a patterned fabric, a pattern-matching operation is required in the sewing process in which individual parts are sewed together. In the case where patterns, which characterize individual parts such as the front and sleeves, are not matched after sewing, the market value of the finished product as clothing may be lowered. However, it is difficult to carry out the entire matching operation solely in the sewing process. Therefore, it is important to intentionally cut out individual parts in the cutting process so that their patterns will be matched after sewed together.

In a conventional automatic marking apparatus the layout of the parts is adjusted, without considering the matching of their patterns, so as to minimize the remaining portion of a sheet-type material after cutting. Hence, it is difficult to use the automatic marking apparatus when the parts to be cut have patterns to be matched, though the automatic making apparatus can be used when automatic cutting is to be performed with respect to a sheet-type material with no pattern or with patterns which might be ignored to match. This is because fabrics and like materials stretch or shrink easily when a sheet-type material is unrolled, the patterns thereon shifts easily from their intended positions. Consequently, it is necessary after automatic marking to adjust the position of the sheet-type material so as to match with the marking data. However, this procedure is extremely difficult, since clothing products, particularly men's or women's clothes, are mostly made of patterned fabrics.

When the conventional marking apparatus is used in combination with the automatic cutting apparatus, it is necessary to eliminate the shift in position of the patterns on a real sheet-type material from the calculated data on patterns. In practice, the sheet-type material is often shifted from its intended position due to its stretching or shrinking. To realize the matching with ideal patterns, the sheet-type material, after being positioned on the table of the cutting apparatus in accordance with layout data stored in the memory of the marking apparatus, is fixed thereto with needles or the like. Such procedures require a plenty of time, so that time-saving effects cannot be expected from the automatic marking and cutting of the sheet-type material. In addition, though the time required for cutting may be further saved by cutting a plurality of layered sheets at a time, more labor is needed to adjust the positions of the patterns. Moreover, since the sheet-type material spread over the table of the cutting apparatus is large in size, a plurality of operators are needed to adjust the positions of the patterns on the sheet-type material.

Japanese unexamined patent publication No. JP A 2-277878 and Japanese examined patent publication No. JP B 1-33587 propose the improved methods of matching patterns. According to the prior art disclosed in Japanese unexamined patent publication No. JP A 2-277878, manual marking is performed prior to cutting: first, clothing patterns in the shapes of individual parts are manually laid out on a sheet-type material to be cut so that the patterns on the sheet-type material are matched; and, then, the surface of the sheet-type material on which the clothing patterns are laid out is scanned by a scanner to obtain cutting data by image processing, followed by automatic cutting. According to the prior art disclosed in Japanese examined patent publication No. JP B 1-33587, each part to be cut is provided with a point at which patterns are matched for each design: the position of each pattern on the unrolled sheet-type material is adjusted based on a matching relationship determined by the whole design with respect to the pattern-matching points, followed by automatic cutting.

In the prior art disclosed in Japanese unexamined patent publication No. JPA 2-277878, it is necessary in the marking process to lay out individual clothing patterns while matching designs. When the sheet-type material such as a fabric has patterns, the layout of patterns in a given position of the sheet-type material is different from sheet to

sheet, due to the elasticity of the sheet-type material. Although the conventional marking apparatus calculates the data on the layout of parts on the basis of the theoretical layout of patterns, desired layouts of patterns are not realized on parts, due to the shift of patterns from the intended positions. In the prior art disclosed in Japanese examined patent publication JP B 1-33587, it is required to provide a spacing for adjustment between each adjacent two patterns, so that it is difficult to use the sheet-type material fully efficiently.

An object of the present invention is to provide a pattern matching method and device for an automatic cutting apparatus whereby both automatic marking and cutting can be performed with respect to a patterned sheet-type material, such as a fabric, by eliminating the difference in position between the theoretical layout and real layout of the patterns so that the sheet-type material can be used efficiently.

Disclosure of Invention

The present invention provides a pattern-matching method for an automatic cutting apparatus whereby a part which needs pattern matching is cut out of a patterned sheet-type material, comprising the steps of:

selecting a characteristic point of a theoretical pattern layout on the sheet-type material and storing in a memory positional data of the characteristic point and part data which indicates the position of the part which needs pattern matching with respect to the characteristic point;

detecting the position of the characteristic point on the unrolled sheet-type material with patterns on the basis of the theoretical pattern layout;

calculating a deflection between the detected position of the characteristic point and the positional data of the characteristic point which has been stored in the memory; and

placing the part which needs pattern matching in an adjusted position on the unrolled sheet-type material with patterns, the adjusted position being determined by modifying the part data stored in the memory on the basis of the deflection calculated.

The invention is characterized in that, in the case where the position of the pattern-matching part pattern is adjusted and the part consequently overlaps another pattern-matching part pattern which has already had its position adjusted, the position of the pattern-matching part pattern is adjusted again on the basis of another characteristic point in another position which is different from the characteristic point detected on the sheet-type material on the basis of the theoretical pattern layout.

The invention is also characterized in that a part which does not need pattern matching is also cut out of the patterned sheet-type material.

The invention also provides a pattern-matching device for an automatic cutting apparatus whereby a part which needs pattern matching is cut out of a patterned sheet-type material fixed onto a table, comprising;

a memory for storing positional data of a characteristic point which is in advance determined in a theoretical pattern layout on the sheet-type material and part data which indicates the position of the part which needs pattern matching with respect to the characteristic point;

means for capturing, over the unrolled sheet-type material with patterns, the surface vision thereof in the vicinity of the position indicated by the positional data of the characteristic point stored in the memory;

means for calculating, in response to an output from the vision capturing means, the deflection between the position of the characteristic point on the unrolled sheet-type material with patterns, which was detected from the surface vision, and the positional data of the characteristic point which has been stored in the memory; and

means for marking which determines, in response to an output from the deflection calculating means, the position of the part which needs pattern matching on the unrolled sheet-type material with patterns by modifying the part data stored in the memory on the basis of the deflection calculated.

The invention is further characterized in that the vision capturing means is movable over the table, and the deflection detecting means comprises: means for displaying the surface vision in the vicinity of the characteristic point in response to the output from the vision capturing means so that the position of the characteristic point stored in the memory is superpose on the surface vision being displayed;

means for directing the vision capturing means to move over the table with reference to the display means; and

means for calculating the deflection, in response to an output from the directing means, on the basis of the distance covered by the vision capturing means which has been moved so as to shift the characteristic point in the surface vision displayed by the display means to the position of the characteristic point superposed on the surface vision displayed.

According to the invention, the automatic cutting apparatus cuts the parts which need pattern matching out of the patterned sheet-type material. Pattern matching in the cutting process is performed by modifying the part data stored in the memory. The position of a part is adjusted by

selecting a characteristic point of the theoretical pattern layout on the sheet-type material, calculating the positional deflection between the theoretical characteristic point and the real characteristic point on the unrolled sheet-type material, and modifying the part data on the basis of the deflection calculated. The positional adjustment is repeatedly carried out for all the parts that need pattern matching, so that their theoretical pattern layouts coincide with their real pattern layouts on the sheet-type material. Thus, marking can be performed by easily placing the parts which need pattern matching on the sheet-type material even when the pattern layout on the sheet-type material undergoes a change due to the elasticity or the like of the sheet-type material. The modified part data or marking data is stored in the memory, based on which automatic cutting is performed.

According to the invention, when the pattern-matching part pattern overlaps, while its position is being adjusted, another pattern-matching part pattern which has already had its position adjusted, the positional adjustment of the pattern-matching part pattern is continued on the basis of another characteristic point. When cutting is conducted based on the part data including ten parts which need pattern matching, for example, a case is supposed in which overlapping is caused by the marking procedure for the fifth part that needs pattern matching in the theoretical part data stored in the memory. The data on the first to fourth parts that need pattern matching is not modified again, for their positions have already been adjusted. Marking is performed again based on the data on the remaining parts including the fifth to tenth patterns with patterns to be matched, which have not been processed yet. Pattern matching is performed on the basis of the characteristic points in this marking process, similarly to the first marking process. Thus, the theoretical positions of the parts which need pattern matching can easily be adjusted on the basis of the deflection of the pattern layout on the real sheet-type material. In addition, marking is repeated only when necessary, so that the optimum automatic marking can be performed in accordance with real patterns on the sheet-type material. Consequently, pattern matching and marking can be carried out appropriately.

According to the invention, the part which does not need pattern matching is also cut out of the patterned sheet, so that scope for adjusting the positions of the parts which need pattern matching is enlarged by repositioning the patterns which do not need pattern matching.

According to the invention, the automatic cutting apparatus cuts parts which need pattern matching out of the patterned sheet-type material fixed onto the table. The pattern matching device includes the memory, vision capturing means, deflection calculating means, and marking means. In the memory are stored the positional data of the characteristic point which is determined in advance in the theoretical pattern layout on the sheet-type material and the part data which indicates the positions of the parts which need pattern matching with respect to the characteristic point. The vision capturing means captures the surface vision in the vicinity of the position indicated by the positional data of the characteristic point stored in the memory. In response to an output from the vision capturing means, the deflection calculating means calculates the deflection between the positional data of the characteristic point stored in the memory and the real position of the characteristic point on the unrolled sheet-type material with patterns, so that the deflection data obtained is supplied to the marking means by feedback. The marking means modifies the part data stored in the memory on the basis of the deflection calculated, so as to determine the position of the part which needs pattern matching on the unrolled sheet-type material. Since the deflection between the characteristic points is calculated in order to modify the part data and to determine the position of the part which needs pattern matching, pattern matching can be carried out easily and promptly.

According to the invention, the vision capturing means is movable over the table. The deflection detecting means includes the display means and the calculating means. The display means displays the vision of the vicinity of the characteristic point which was captured by the vision capturing means and superimposes, on the vision being displayed, the position of the characteristic point obtained from the content of the memory. The directing means directs the vision capturing means to move over the table while capturing the vision to be displayed. The calculating means calculates the deflection on the basis of the distance covered by the vision capturing means which has been moved so as to shift the characteristic point in the surface vision displayed by the display means to the position of the theoretical characteristic point superimposed on the surface vision. Thus, the deflection necessary for pattern matching can be calculated easily and promptly.

As described above, according to the invention, the deflection between the characteristic point in the theoretical pattern layout on the patterned sheet-type material and the real characteristic point on the unrolled sheet-type material is calculated, and the part data is modified based on the deflection calculated, so as to position the related part which needs pattern matching on the sheet-type material. Consequently, the shift of the real pattern layout from the theoretical pattern layout is elimi-

nated, thereby realizing automatic marking and cutting of the patterned sheet-type material. Since the position of the part which needs pattern matching is adjusted by eliminating the shift of the real pattern layout from the theoretical one on the basis of the distinct characteristic points, pattern matching can easily be carried out on the basis of the characteristic points. That is, after automatic marking is performed on the basis of the theoretical pattern layout, the marking data obtained can be modified in accordance with the unrolled sheet-type material. Since an extra spacing is not provided between each two adjacent patterns, the sheet-type material can be used efficiently.

According to the invention, when overlapping occurs between the part with the pattern to be matched wherein the position of which is adjusted, and another part with the pattern to be matched wherein the position of which has already been adjusted, the position of the part with the pattern to be matched is adjusted on the basis of another characteristic point which is different from the characteristic point detected based on the theoretical pattern layout on the sheet-type material, and therefore, the part with the pattern to be matched is repositioned only when required without changing the position of another pattern with a pattern to be matched which has already been adjusted. For example when cutting is conducted based on the part data including ten parts which need pattern matching, a case is supposed in which overlapping is caused by the marking procedure for the fifth part that needs pattern matching in the theoretical part data stored in the memory. The data on the first to fourth parts that need pattern matching is not modified again, for their positions have already been adjusted. Marking is performed again based on the data on the remaining parts including the fifth to tenth parts with patterns to be matched, which have not been processed yet. Pattern matching is performed on the basis of the characteristic points in this marking process, similarly to the first marking process. Thus, the theoretical positions of the parts which need pattern matching can easily be adjusted on the basis of the deflection of the pattern layout on the real sheet-type material. In addition, when the shift of the real pattern layout from the theoretical one is remarkable, marking is repeated only when necessary, so that the optimum automatic marking can be performed in accordance with real patterns on the sheet-type material. According to the present invention, pattern matching can easily be carried out, even when the shift between the real and theoretical pattern layouts is remarkble, by repositioning parts which do not need pattern matching.

According to the invention, the vision in the vicinity of the characteristic point on the unrolled sheet-type material with patterns is captured so as to calculate the deflection between the characteristic point in the vision captured and the positional data of the characteristic point stored in the memory. The deflection data is fed back so as to adjust the position of the part with the pattern to be matched in accordance with the real pattern layout on the unrolled sheet-type material with patterns, so that pattern matching can easily be carried out in the marking process.

According to the invention, the vision capturing means for capturing the vision in the vicinity of the characteristic point on the unrolled sheet-type material with patterns is movable over the table, and the deflection detecting means displays, on the display means, the surface vision from the vision capturing means together with the theoretical position of the characteristic point. When the directing means directs the vision capturing means to move so as to shift the real characteristic point to the theoretical characteristic point, the deflection can easily be calculated based on the distance covered by the vision capturing means, and therefore, pattern matching can be carried out easily and promptly.

Brief Description of Drawings

FIG. 1 is a block diagram diagrammatically showing the structure of an embodiment of the present invention;

FIG. 2 is a partially cutaway side view diagrammatically showing the cutting apparatus 1 shown in FIG. 1;

FIG. 3 is a front view diagrammatically showing the deflection controller regulator 3 shown in FIG. 1;

FIG. 4 is a front view diagrammatically showing a vision on the monitor 31 shown in FIG. 1;

FIG. 5 is a plan view showing the layout of parts on the sheet-type material 14 shown in FIG. 1;

FIG. 6 is a plan view showing the layout of parts on an ideal sheet-type material 14i, wherein the sheet-type material 14 shown in FIG. 1 is assumed to have no elasticity;

FIG. 7 is a plan view of a fabric 15 for inputting the layout data to the memory 23 in the embodiment shown in FIG. 1;

FIG. 8 is a plan view showing the fabric data 15a to be inputted to the memory 23 shown in FIG. 1;

FIG. 9 is a plan view showing a part 60 to be stored in the memory 23 shown in FIG. 1;

FIG. 10 is a plan view showing the relationship between the part 60 to be inputted to the memory 23 shown in FIG. 1 and a pattern matching mark 60b serving as a reference point;

FIG. 11 is a flow chart showing the procedure sequences of the pattern matching method in the embodiment shown in FIG. 1; and

FIG. 12 is a block diagram diagrammatically showing the electric constitution of the pattern matching device in the embodiment shown in FIG. 1.

Best Mode for Carrying Out the Invention

FIG. 1 diagrammatically shows the structure of an apparatus for practicing the pattern-matching method of the present invention. A cutting apparatus 1 carries out cutting in response to a head moving signal 0 transmitted from a marking apparatus 2 via a line L1. To achieve the patterns matching in cutting, the cutting apparatus provides a video signal V for a deflection controller 3 via a line L2. The marking apparatus 2 supplies marking reference data M to the deflection controller 3 via a line L3. As described below, the marking reference data M is produced based on the positional data of the characteristic point. The deflection controller 3 calculates deflection data D, in accordance with the video signal V and the marking reference data M, and provides it with the marking apparatus 2 via a line L4. The marking apparatus 2 modifies the head moving signal 0 which is provided on the basis of the deflection data D for the cutting apparatus 1 via the line L1.

To the cutting apparatus 1 is provided a sheet-type material such as a fabric, which has been unrolled by an unrolling device 4. The part of clothes which were cut by the cutting apparatus 1 are picked up by a pickup device 5.

The cutting apparatus 1 will be further described with reference to FIG. 2. FIG. 2 is a cross sectional view diagrammatically showing the cutting apparatus 1. The cutting apparatus 1 is provided with a head portion 11 which is moved in response to the head moving signal 0 transmitted via the line L1. The head portion 11 can be moved horizontally over a table 13 by a moving device 12. The head portion 11 includes a cutter 11a and a camera 11b. The camera 11b is attached directly to the cutter 11a. A blade 11c extends vertically downward from the cutter 11a. The blade 11c cuts the sheet-type material 14 laid on the table 13. As shown in the partial cross section, the surface of the table 13 is composed of a brush 13a for pulling down the sheet-type material 14 by suction to be fixed. When the sheet-type material 14 is composed of several layers of fabrics, a plastic sheet 14a is superposed on top of the layers to ensure the fixing of the sheet-type material 14 onto the table 13 by suction.

The marking apparatus 2 shown in FIG. 1 includes a central processing unit (hereinafter referred to as CPU) 21, a monitor 22, and a memory 23. The CPU 21 executes the marking and like processings and provides the head moving signal 0 for the cutting apparatus 1 via the line L1. The monitor 22 displays a part to be cut and the like. Data on a part to be cut and other information are stored in the memory 23.

Referring now to FIGS. 3 and 4, the deflection controller 3 will be described. FIG. 3 is a front view diagrammatically showing the deflection controller 3 and FIG. 4 shows a vision for a monitor 31 included by the deflection controller 3. In addition to the monitor 31, the deflection controller 3 includes a deflection adjusting device 32 as well. The monitor 31 displays, based on the marking reference data M provided from the marking apparatus 2 via the line L3, a reference mark 33 in the center of the screen which is superposed on the vision of the surface of the sheet-type material 14. On the surface of the sheet-type material 14, an intersecting point of a vertical pattern 40 and a lateral pattern 50, for example, is selected as the characteristic point, so that the vision of the intersecting point is superposed on the reference mark 33 when the sheet-type material is not stretched or shrunk. Hence, an arrow mark 34 shows the direction in which adjustment should be performed.

The deflection controll 32 comprises a deflection amount indicator 35 and operation indicator 36 so as to adjust the deflection in the direction 34 on the monitor 31. The deflection amount indicator 35 includes a movement directing element 35a, which can be composed of a truck ball or the like, and a rotation directing element 35b. The operation indicator 36 includes a button 36a which shows the completion of the movement or rotation directed by the deflection amount indicator 35 and a button 36b which shows the execution of various other commands.

As shown in FIG. 4, the reference mark 33 serves as a reference in defining the outer configuration of a part 60 which needs pattern matching. The monitor 31 may display the part 60 only partially. When the deflection is regulated so as to locate the reference mark 33 on the characteristic point, the deflection is also modified with respect to the other portion of the part 60 that is not displayed on the monitor 31. The data on the position of the characteristic point and the data on the parts which need pattern matching relating to individual characteristic points are stored in the memory 23.

FIG. 5 shows the layout of parts on the sheet-type material 14 before the deflection is modified. FIG. 6 shows the layout of the parts on the ideal sheet-type material 14i which is free from stretching and shrinking. The sheet-type material 14 has, for example, a checkered pattern consisting of vertical lines and lateral lines. Clothes made of a

fabric with such a checkered pattern definitely need pattern matching, for a mismatch of the patterns is conspicuous in this case. Consequently, vertical reference lines 41 to 45 and lateral reference lines 51 to 53 are selected so that their intersecting points serve as the characteristic points.

FIGS. 7 and 8 show the selection of the vertical and lateral reference lines. The fabric 15 shown in FIG. 7 has a checkered pattern which is composed of the vertical pattern 40 and the lateral pattern 50. Since the vertical pattern 40 and lateral pattern 50 consist of a plurality of stripes, the lateral reference lines 50a designated by ① and ② and the vertical reference lines 40a designated by ③ and ④ are selected so as to produce fabric data 15a shown in FIG. 8 and store it in the memory 23 of the marking apparatus 2. In this way, the vertical reference lines 41 to 45 and lateral reference lines 51 to 53 are determined on the ideal sheet-type material 14i. Parts 61 to 65 which need the patterns matching of are laid out on the basis of the intersecting points of the vertical reference lines 41 to 45 and lateral reference lines 51 to 53, which serve as the characteristic points. Parts 66 and 67 which do not need patterns matching of are laid out around the parts 61 to 65 which need pattern matching. In the case of a design other than checks, reference lines which characterize the design are similarly selected to produce the fabric data, so as to provide the characteristic points.

On the sheet-type material 14 shown in FIG. 5, shifs arise between the characteristic points of the parts 61, 64, and 65 with patterns to be matched, due to the stretching or shrinking of the sheet-type material 14. In order to modify the deviations, the visions of the regions denoted by reference numerals 31a, 31b, and 31c are displayed on the monitor 31, so that the positions of the parts 61, 64, and 65 are adjusted in the directions 34a, 34b, and 34c on the basis of the reference marks 33a, 33b, and 33c, respectively. In the case where the part 61, 64, or 65 which needs pattern matching overlaps the part 66 or 67 which does not need pattern matching, the position of the part 66 or 67 is modified. In the case where one of the parts 61 to 65 with patterns to be matched overlaps another of the parts 61 to 65 which has already had its position adjusted, another point is selected as the characteristic point for matching patterns.

FIGS. 9 and 10 illustrate a method of selecting the characteristic point for the part 60 with a pattern to be matched with reference to the fabric data 15a. The configuration of the part 60 which needs pattern matching is defined on the basis of the pattern matching reference line 60a. The relationship between the pattern matching reference line 60a and the vertical and lateral patterns 40a and 50a is determined by selecting the pattern matching mark 60b as the characteristic point. The pattern matching mark 60b is selected in the vicinity of the center of the part 60 where the striped design is distinct. Once the positional relationship between the pattern matching mark 60b and the pattern matching reference line 60a is determined, the position of the part 60 with a pattern to be matched, which has been determined on the basis of the pattern matching reference line 60a, can also be determined on the basis of the pattern matching mark 60b.

Each of the displayed regions 31a, 31b, and 31c shown in FIG. 5 is about the size of a square side 30 cm. The modification in size of the sheet-type material 14 being stretched or shrunk is about 1 cm. Accordingly, it is easy for an operator to adjust the deflection, while observing the monitor 31, by means of the deflection adjusting device 3.

According to the present embodiment, the sheet-type material 14 composed of a single sheet can be spread on the table 13 by alignment at the sides thereof, so that one operator can easily modify its position while observing the vision displayed on the monitor 31. The sheet-type material 14 composed of a plurality of layers can also be cut by fixing the layers so that the pattern layout of one layer is not shifted from that of another layer, without matching the pattern layout of the real sheet-type material 14 with that of the ideal sheet-type material 14i. Furthermore, since it is not required to provide a spacing between each adjacent two of the patterns, the sheet-type material 14 can be used efficiently, which is beneficial especially when the sheet-type material 14 is expensive.

FIG. 11 is a flow chart showing the procedure sequences of the pattern matching method in an embodiment of the invention described above. The procedures are initiated with a step a1. In a step a2, an ideal pattern pitch, which is the data on the vertical reference lines 41 to 45 and lateral reference lines 51 to 53 on the ideal sheet-type material 14i shown in FIG. 6, is inputted to the marking apparatus. In a step a3, as shown in FIG. 6, the parts 61 to 65 which need pattern matching and parts 66 and 67 which do not need pattern matching are laid out on the ideal sheet-type material 14i so as to carry out marking. In a subsequent step a4, the marking apparatus 2 transmits the head moving signal 0 to the cutting apparatus 1, so that the part which needs pattern matching is selected from the marking data and that the camera of the head portion is moved to the pattern matching point. In a step a5, it is examined on the monitor 31 of the deflection controller whether the pattern matching point obtained from the marking data which was marked in accordance with the ideal pitch coincides with the real pattern layout of the

fabric or not. And in a step a6, as illustrated in FIGS. 3 and 4, it is judged whether the pattern matching point from the marking data coincides with the pattern on the fabric or not. In the case of no coincidence, the camera 11b of the head portion is moved by the deflection amount indicator 35.

In a step a8, the amount of deflection is calculated based on the movement of the camera 11b. The deflection controller 3 provides the deflection data D, which shows the amount of deflection calculated, for the marking device 2. In a step a9, the marking apparatus 2 moves the part depending on the amount of deflection. In a step a10, it is examined whether the pattern-matching part pattern, which has been moved, overlaps with another part or not. In a step a11, the presence of such overlapping is judged. In the case of overlapping, the procedures go on to a step a12 in which it is examined whether the overlapping is with another part of the pattern which has already been matched or not. The judgment on the examination is conducted in step a13, and when the answer is no, the procedures go on to a step a14 in which the other parts are marked again. When the answer obtained in the stem a13 is yes, the camera 11b attached to the head portion 11 is moved to another pattern on the fabric. When the step a15 is finished, the procedures from the step a8 are repeated.

In the case where it is judged in the step 6a that there is a coincidence, where it is judged in the step a11 that there is no overlapping, or where the step a14 is finished, the procedures go on to a step a16 in which the pattern of another part is matched. In the case where there are no more parts left that need pattern matching, it is judged in a step a17 that the previous part is the final. In a step a18, since the marking data is finished in accordance with the real fabric, the marking apparatus 2 transfers to the marking data the cutting apparatus 1, based on which the sheet-type material 14 is cut. Subsequently, the procedures are finished by a step a19. In the case where it is judged in the step a17 that the previous part is not the final one, the procedures from the step a4 are repeated.

As described above, the deflection data D is provided for to the marking apparatus 2 by feedback, so that the theoretical pattern layout which is stored in the memory 23 is modified to coincide with the real pattern layout on the unrolled sheet-type material 14. Such a procedure is conducted with an electric constitution shown in FIG. 12. The cutting apparatus 1 includes a controller 16 for the cutting apparatus, a circuit 17 for driving the head in the X direction, a circuit 18 for driving the head in the Y direction, a cutter-driving circuit 19 and a moving device 12. As described above, the camera 11b is attached to the moving device 12.

To the controller 16 in the cutting apparatus 1 is provided a head moving signal 0 from the marking apparatus 2 via the line L1, so as to control the moving device 12 via the driving circuits 17 and 18.

The marking apparatus 2 includes, in addition to the CPU 21, monitor 22 for display and memory 23, a marking operating circuit 24, a marking processing circuit 25, and a display processing circuit 26. To the marking operating circuit 24 is inputted the positional data for marking on the part 60 with a pattern to be matched and the pattern matching mark 60b according to the method illustrated in FIGS. 9 and 10. The marking processing circuit 25 transmits a head moving signal 0 for moving the camera 11b so as to capture the vision in the vicinity of the reference point. The display processing circuit 26 executes the processing for displaying the part 60 which needs pattern matching on the monitor 22 of the marking apparatus and on the monitor 31 of the deflection controller 3.

The deflection controller 3 includes the monitor 31 and the deflection regulator device 32. The deflection regulator device 32 includes the deflection amount indicator 35 and a video signal synthesizing circuit 37. The video signal synthesizing circuit 37 synthesizes a video signal for displaying a vision on the monitor shown in FIGS. 3 and 4, in response to a video signal V transmitted from the camera 11b via the line L2 and to the marking reference data M provided from the marking apparatus 2 via the line L3, and transmits it to the monitor 31.

Although the sheet-type material 14 laid on the table 13 of the cutting apparatus 1 is fixed thereto in the embodiment described above so that the deflection amount is calculated by moving the head portion 11, it will easily be understood that the deflection amount can be calculated based on the video signal V form the camera 11b. However, since it is difficult to detect the characteristic point solely from the video signal V, the more accurate deflection amount can be obtained when an operator indicates the deflection amount by matching the characteristic point with the reference mark 33 in the center while observing the vision on the monitor 31. Since the characteristic point is matched with the reference mark 33 in the center of the vision being displayed, the vision is not susceptible to the distortion in the marginal portion of the screen, which is observed when a cathode-ray tube (referred to as CRT) is used as the display device.

Industrial Applicability

As described above, according to the pattern matching method and device for the cutting apparatus of the invention, part of clothes which need pattern matching can easily be cut out of the sheet-type material such as the fabric. Since it is possible to use the sheet-type material efficiently even when pattern matching is performed, they are particularly suitable for cutting the expensive sheet-type material.

Claims

1. A pattern matching method of an automatic cutting machine, for cutting pattern-matching part pattern out of patterned-carrying sheet material comprising:

   selecting a characteristic point of a theoretical pattern layout on the pattern-carrying sheet material and storing in a memory positional data of the characteristic point and part pattern data to indicate the position of the pattern-matching patterns part with respect to the characteristic point;

   detecting the position of the characteristic point on the spread pattern-carrying sheet material according to the theoretical pattern layout;

   calculating deflection between the detected position of the characteristic point and the positional data of the characteristic point which has been stored in the memory; and

   arranging the pattern-matching part pattern on the spread pattern-carrying sheet material to the corrected position corresponding to the part pattern data stored in the memory on the basis of the calculated deflection.

2. The pattern matching method of an automatic cutting machine as claimed in claim 1, wherein, in case the position of the pattern-matching part pattern is corrected, when a pattern-matching part pattern is consequently superposed on another pattern-matching part pattern which arrangement has been already corrected, correcting the arrangement of the pattern-matching pattern on the basis of another characteristic point which has different position from the characteristic point detected on the basis of the theoretical pattern layout of the sheet material.

3. The pattern matching method for an automatic cutting machine as claimed in claim 1 or 2, wherein a part pattern which does not need pattern-matching is also cut out of the pattern-carrying sheet material.

4. A pattern matching apparatus for an automatic cutting machine to cut pattern-matching part pattern out of pattern-carrying sheet material fixed onto a table, comprising:

   a memory for storing positional data of a predetermined characteristic point of a determined theoretical pattern layout of the sheet material in advance and part pattern data to indicate the position of the pattern-matching part pattern with respect to the characteristic point;

   an image taking means for taking surface image of spread pattern-carrying sheet material in the vicinity of the position indicated by the positional data of the characteristic point stored in the memory;

   a deflection calculating means, in response to an output from the image taking means, for displaying the surface image and for calculating the defection between the for the position data indicates as position of the characteristic point detected from the surface image on the spread pattern-carrying sheet material and the positional data of the characteristic point stored in the memory; and

   a marking means, in response to an output from the deflection calculating means, for determining arrangement of the pattern-matching part pattern on the spread pattern-carrying sheet material by correcting the part pattern data stored in the memory on the basis of the calculated defection.

5. The pattern matching apparatus for an automatic cutting machine as claimed in claim 4, wherein

   the image taking means is movable over the table, and

   the deflection calculating means comprises:

   a displaying means, in response to an output from the image taking means, for displaying the surface image in the vicinity of the characteristic point and for superposing the position of the characteristic point stored in the memory on the displayed surface image;

   a directing means for directing the image taking means to move over the table with reference to the displaying means; and

   a calculating means, in response to an output from the directing means for calculating the deflection, on the basis of the distance of the image taking means, when the image taking means being moved so as to shift the characteristic point of the surface image displayed on the displaying means to the position of the characteristic point superposed on the displayed surface image.

Amended claims

1. (Amended) A pattern matching method of an automatic cutting machine, for cutting pattern-matching part pattern out of patterned-carrying sheet material on which the pattern-matching part pattern is arranged according to a theoretical pattern comprising:

selecting a characteristic point easily identified to a theoretical pattern layout on the pattern-carrying sheet material and storing in a memory positional data of the characteristic point and part pattern data to indicate the position of the pattern-matching patterns part with respect to the characteristic point;

detecting the position of the characteristic point on the spread pattern-carrying sheet material;

calculating deflection between to indicate the detected position of the characteristic point and the positional data of the characteristic point which has been stored in the memory; and

arranging the pattern-matching part pattern on the spread pattern-carrying sheet material to the corrected position corresponding to the part pattern data stored in the memory on the basis of the calculated deflection.

2. The pattern matching method of an automatic cutting machine as claimed in claim 1, wherein, in case the position of the pattern-matching part pattern is corrected, when a pattern-matching part pattern is consequently superposed on another pattern-matching part pattern which arrangement has been already corrected, correcting the arrangement of the pattern-matching pattern on the basis of another characteristic point which has different position from the characteristic point detected on the basis of the theoretical pattern layout of the sheet material.

3. The pattern matching method for an automatic cutting machine as claimed in claim 1 or 2, wherein a part pattern which does not need pattern-matching is also cut out of the pattern-carrying sheet material.

4. (Addition) The pattern matching method of the automatic cutting machine as claimed in claim 1 or 2, wherein the characteristic point is selected one by one to each pattern-matching part pattern.

5. (Addition) The pattern matching method of the automatic cutting machine as claimed in claim 1 or 2, wherein the characteristic point is selected inside the pattern-matching part pattern.

6. (Amendment) A pattern matching apparatus for an automatic cutting machine to cut pattern-matching part pattern out of pattern-carrying sheet material on which the pattern-matching part pattern is arranged according to a theoretical pattern, fixed onto a table, comprising:

a memory for storing positional data of a characteristic point easily identified to a determined theoretical pattern layout of the pattern-carrying sheet material in advance and part pattern data to indicate the position of the pattern-matching part pattern with respect to the characteristic point;

an image taking means for taking surface image of spread pattern-carrying sheet material in the vicinity of the position indicated by the positional data of the characteristic point stored in the memory;

a deflection calculating means, in response to an output from the image taking means, for displaying the surface image and for calculating the defection between the for the position data indicates as position of the characteristic point detected from the surface image on the spread pattern-carrying sheet material and the positional data of the characteristic point stored in the memory; and

a marking means, in response to an output from the deflection calculating means, for determining arrangement of the pattern-matching part pattern on the spread pattern-carrying sheet material by correcting the part pattern data stored in the memory on the basis of the calculated defection.

7. (Amendment) The pattern matching apparatus for an automatic cutting machine as claimed in claim 6, wherein

the image taking means is movable over the table, and

the deflection calculating means comprises:

a displaying means, in response to an output from the image taking means, for displaying the surface image in the vicinity of the characteristic point and for superposing the position of the characteristic point stored in the memory on the displayed surface image;

a directing means for directing the image taking means to move over the table with reference to the displaying means; and

a calculating means, in response to an output from the directing means for calculating the deflection, on the basis of the distance of the image taking means, when the image taking means being moved so as to shift the

characteristic point identified out of the surface image displayed on the displaying means to the position of the characteristic point superposed on the displayed surface image.

Brief statement of amendment under article 19(1)

The claims 4 and 5 on filing are changed to the corrected claims 6, 7 respectively, and new claims 4, 5 are added.

In claims 1 and 6, it is made clear that the position of the part with the pattern to be matched is adjusted by selecting the easily identified characteristic point of the theoretical pattern layout on the patterned sheet-type material on which the part with the pattern to be matched has already been disposed.

In the second citation of reference JP, B2,1-33587, after the pattern-matching points have been determined, the distribution of the parts is achieved, and the operation of adjusting the position of pattern-matching points is automatically performed by using the pattern-matching points.

In the first citation of reference JP, B2,2-46708, at least a portion of the fabric design is memorized, and after the vision which is detected by the camera has been recognized, the fabric is moved for adjusting the position.

In the present invention, the characteristic point is selected after the process of disposing the part which needs pattern matching has been completed, with the result that the adjusting operation can be intervened by a man easily.

In claims 4 and 5, it is made clear that the selection of the characteristic point in claims 4 and 5 is different from that in the second citation of reference.

In claim 7, the formation of instructing the characteristic point by a man is made sure.

Fig. 1

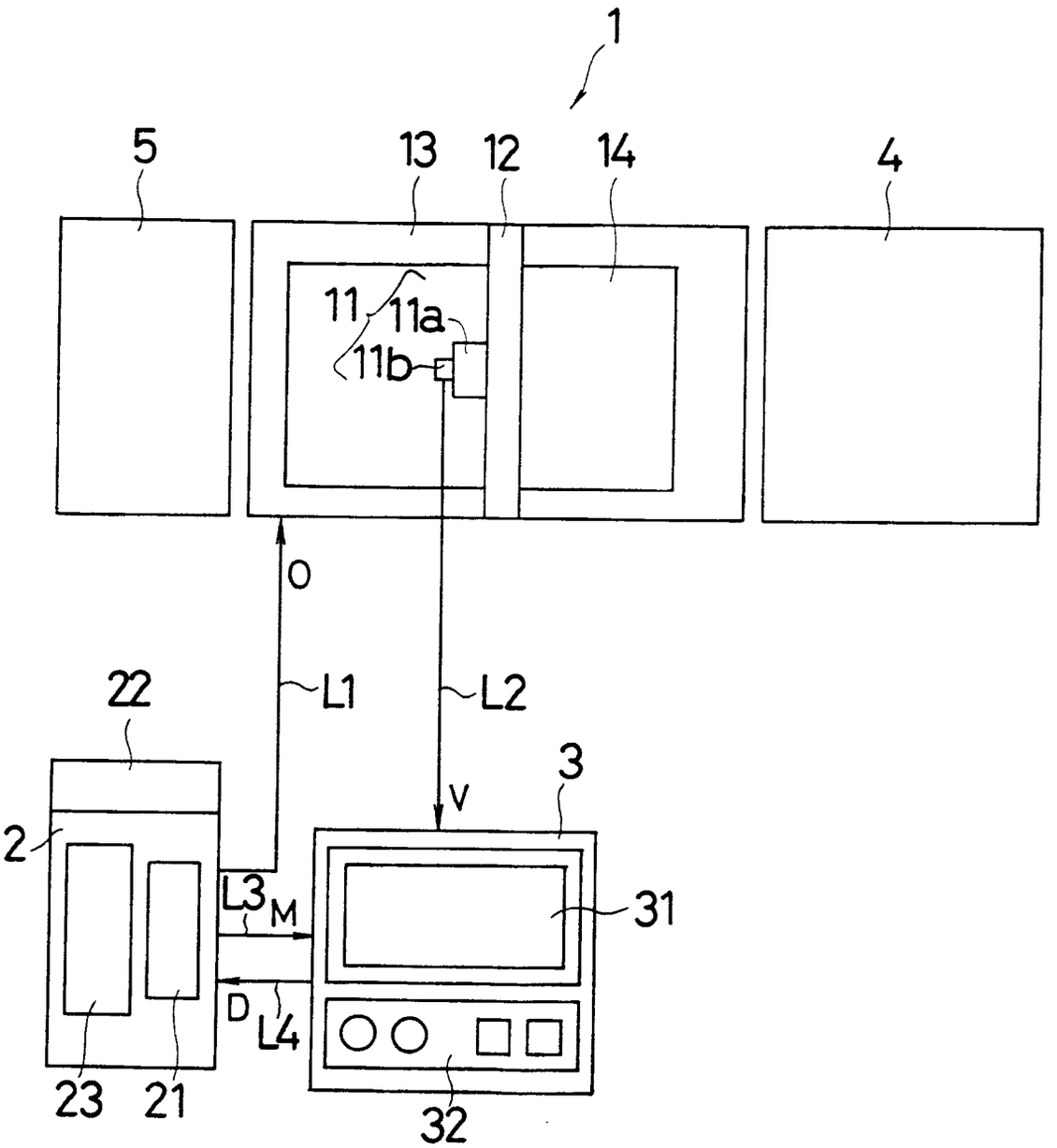


Fig. 2

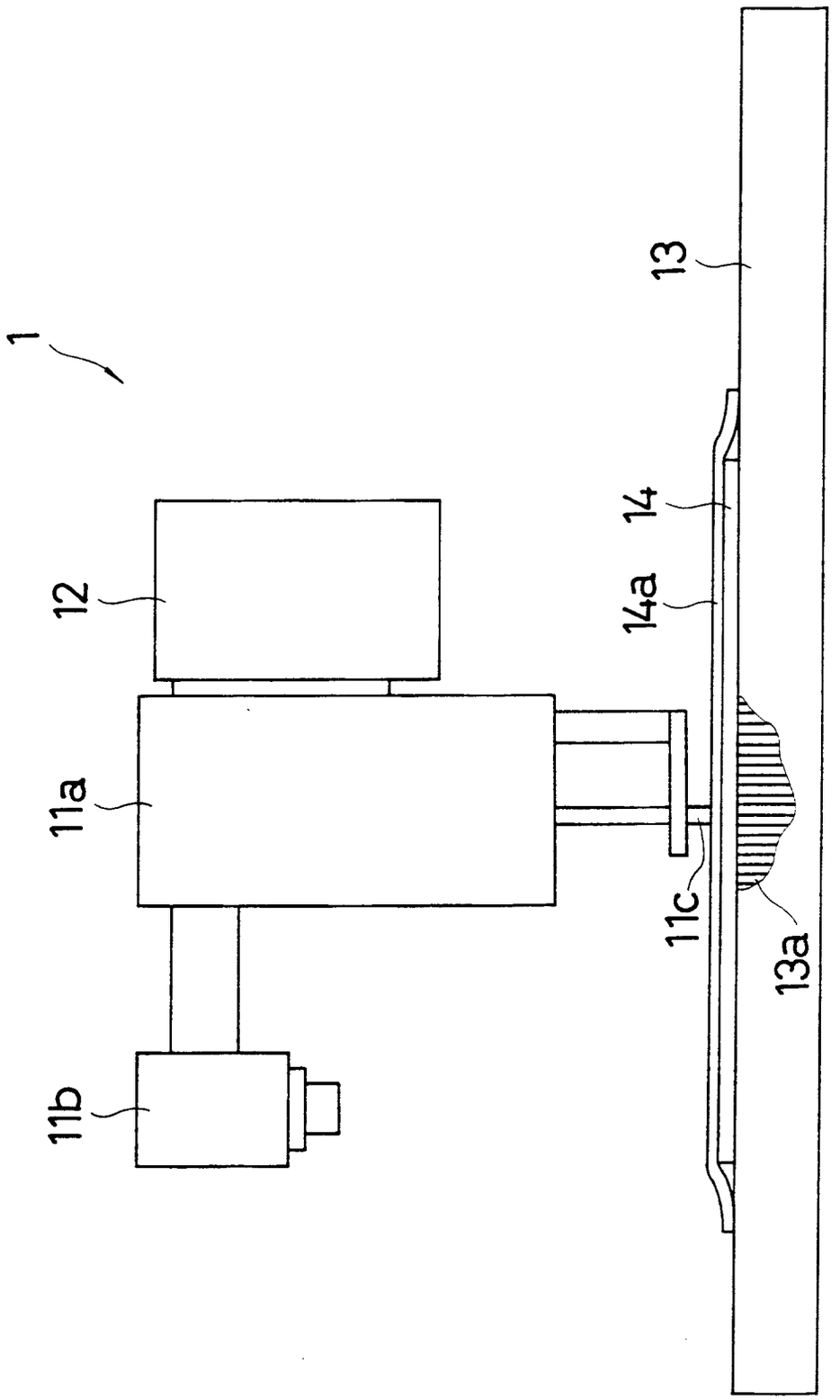


Fig. 3

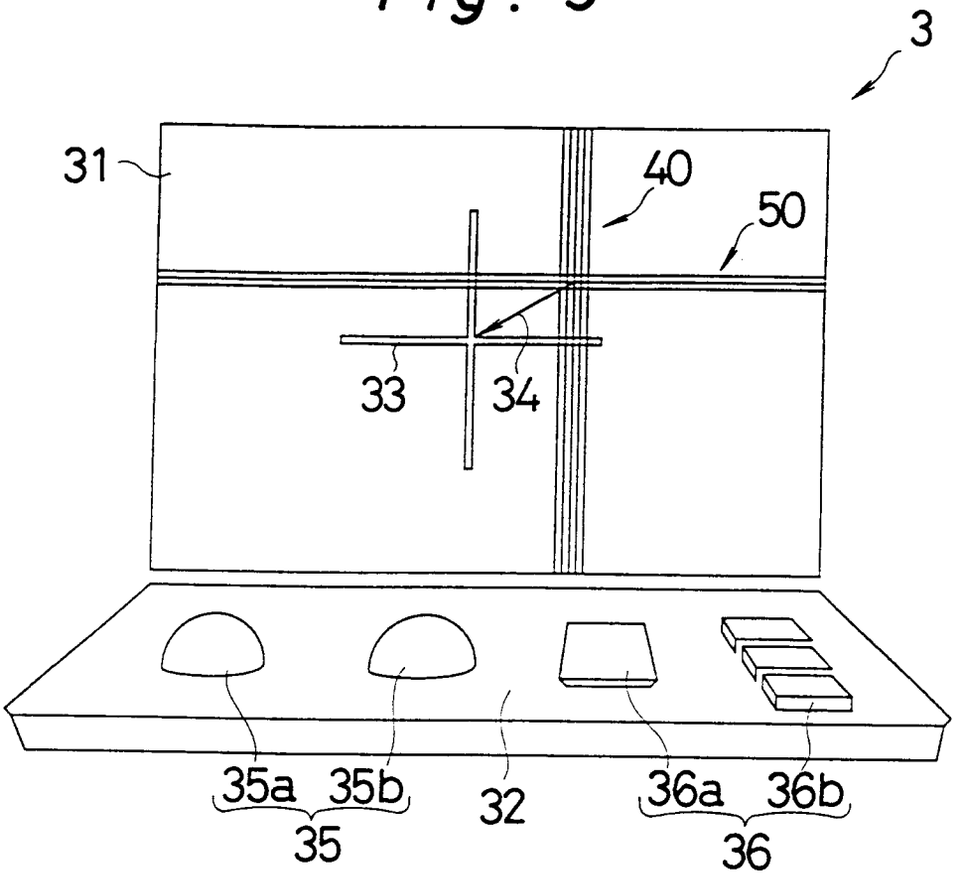


Fig. 4

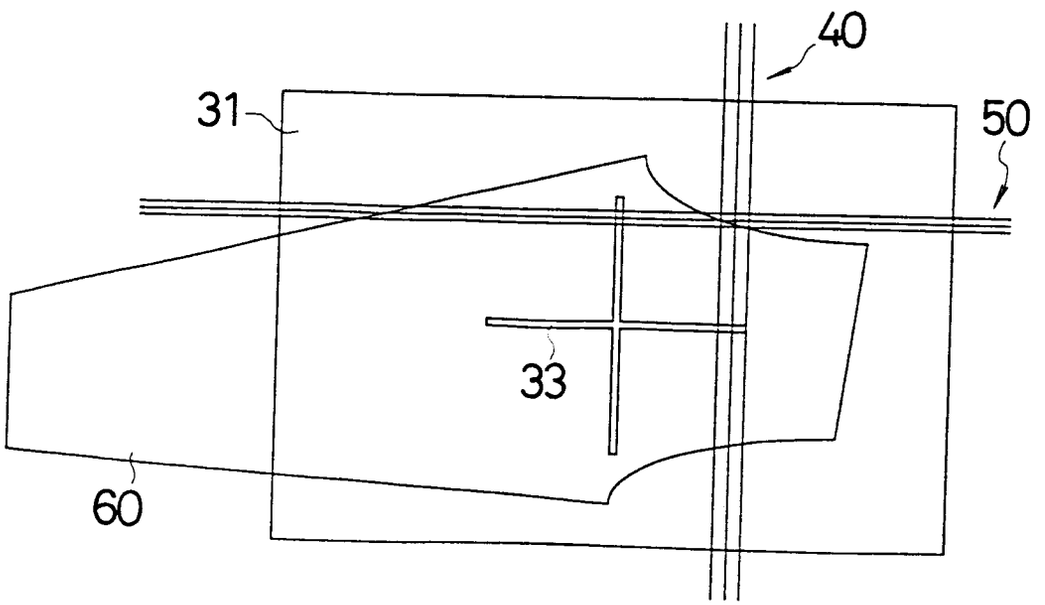
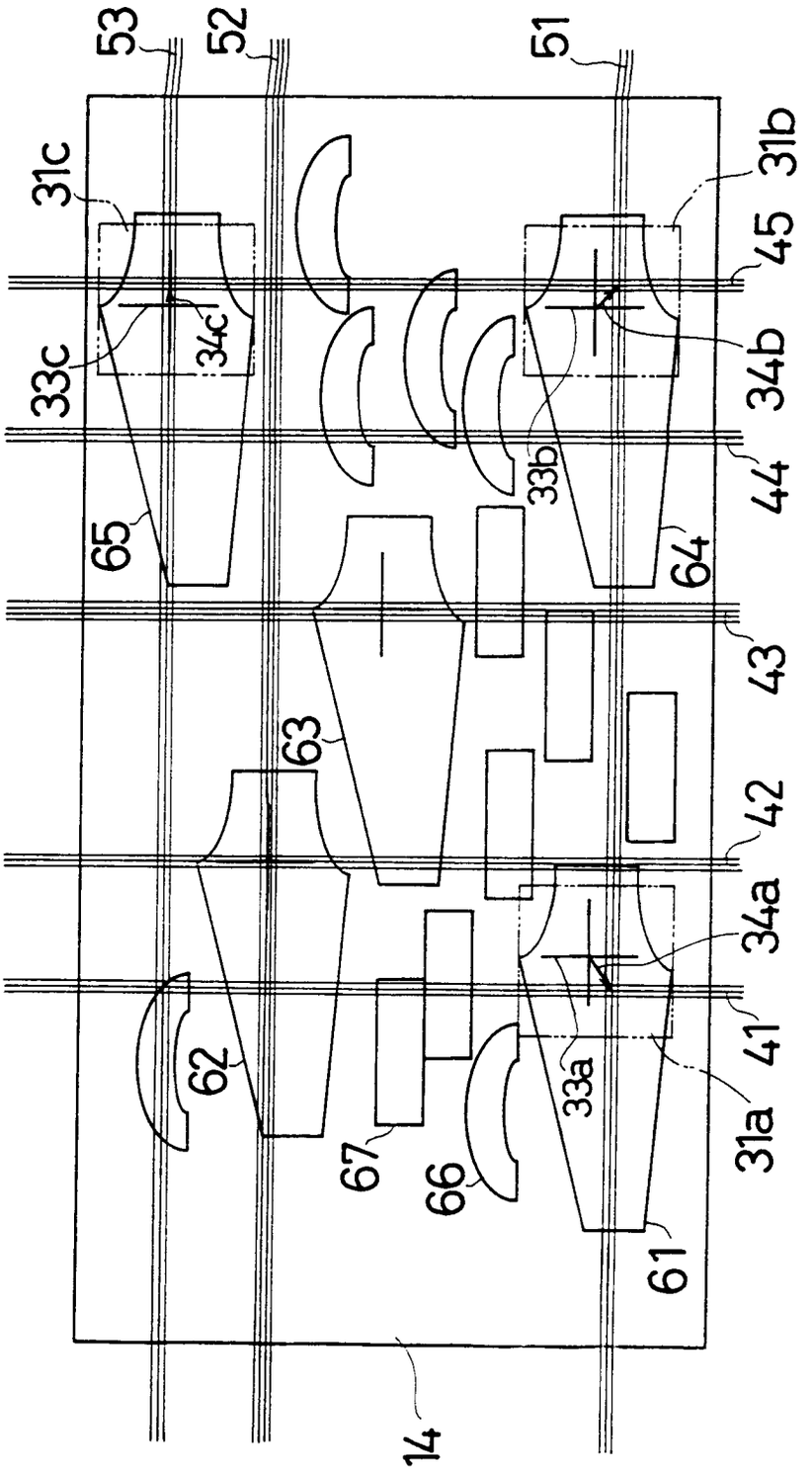


Fig. 5


53
52
51
31c
31b
45
34c
33c
34b
33b
44
65
64
43
63
42
34a
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62
33a
31a
67
66
61
14

Fig. 6

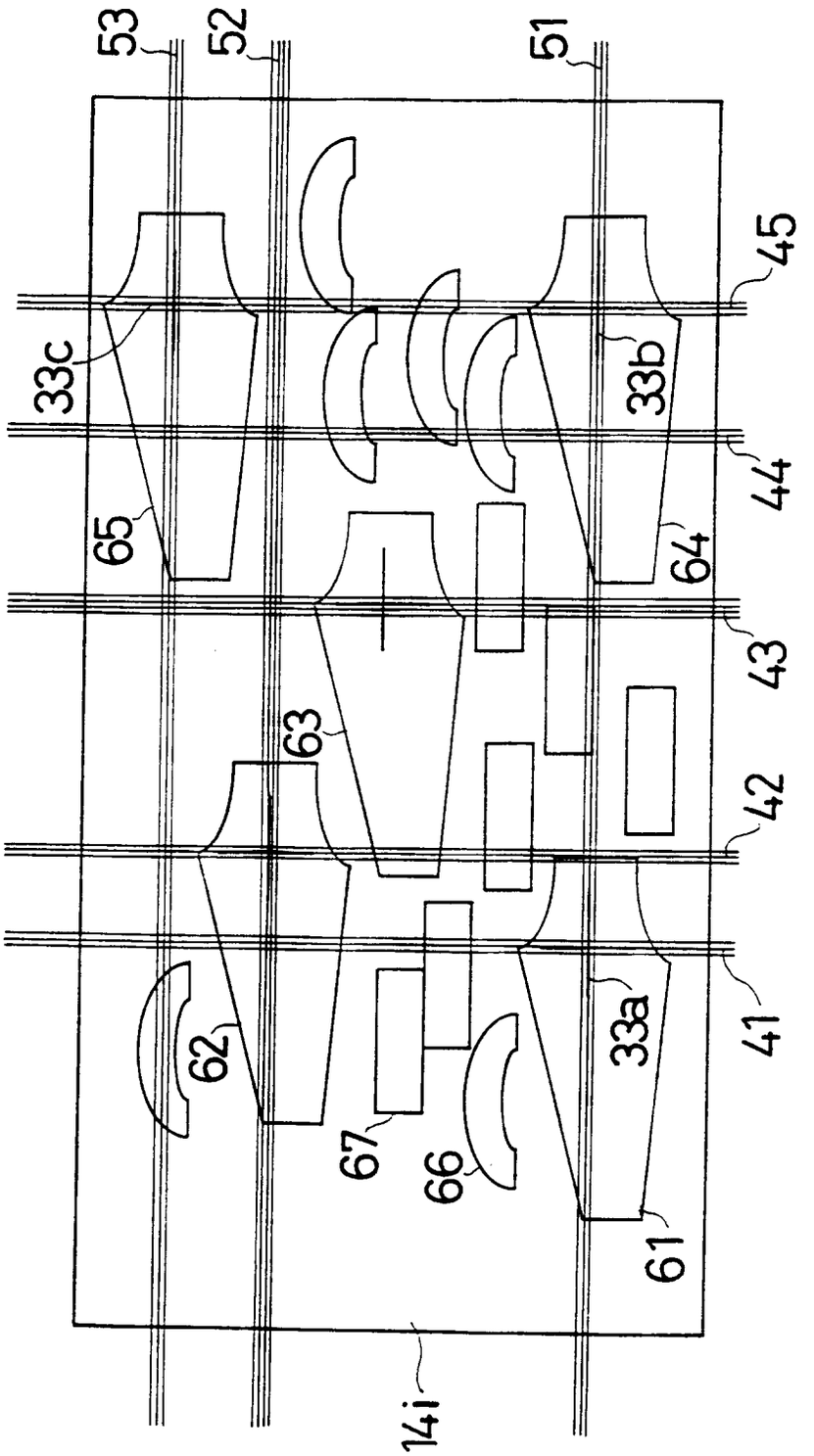


Fig. 7

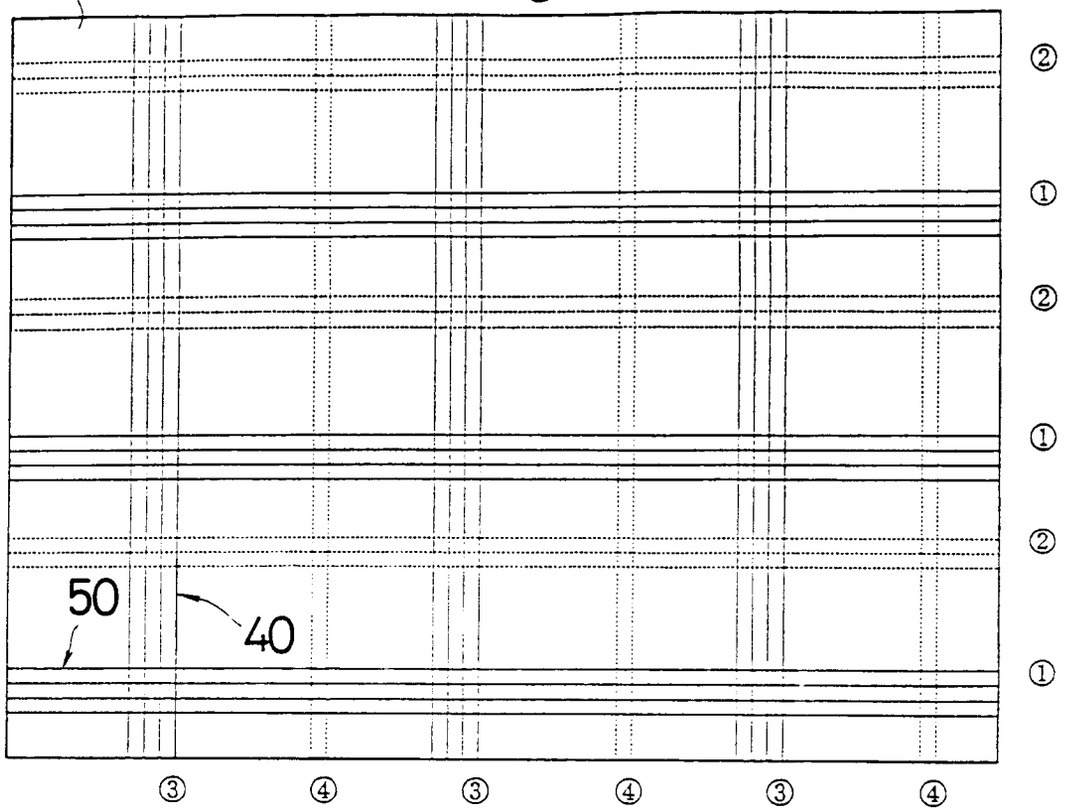


Fig. 8

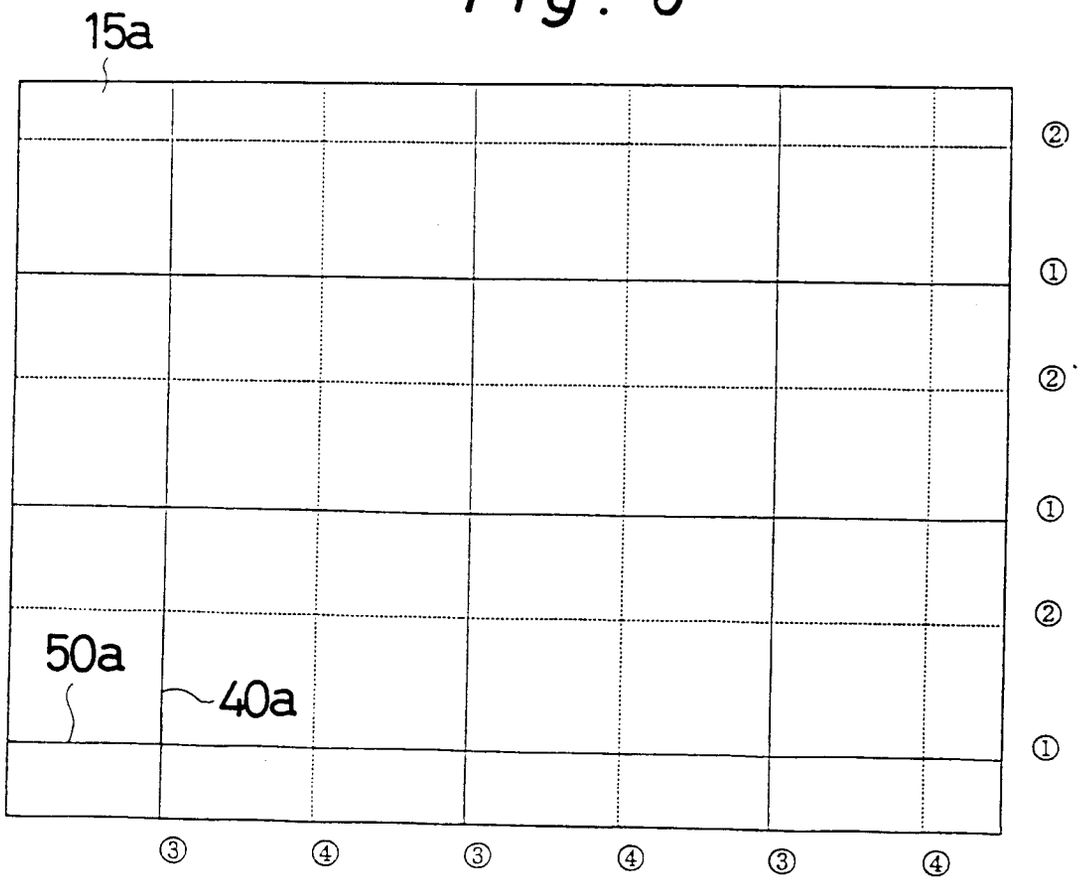


Fig. 9

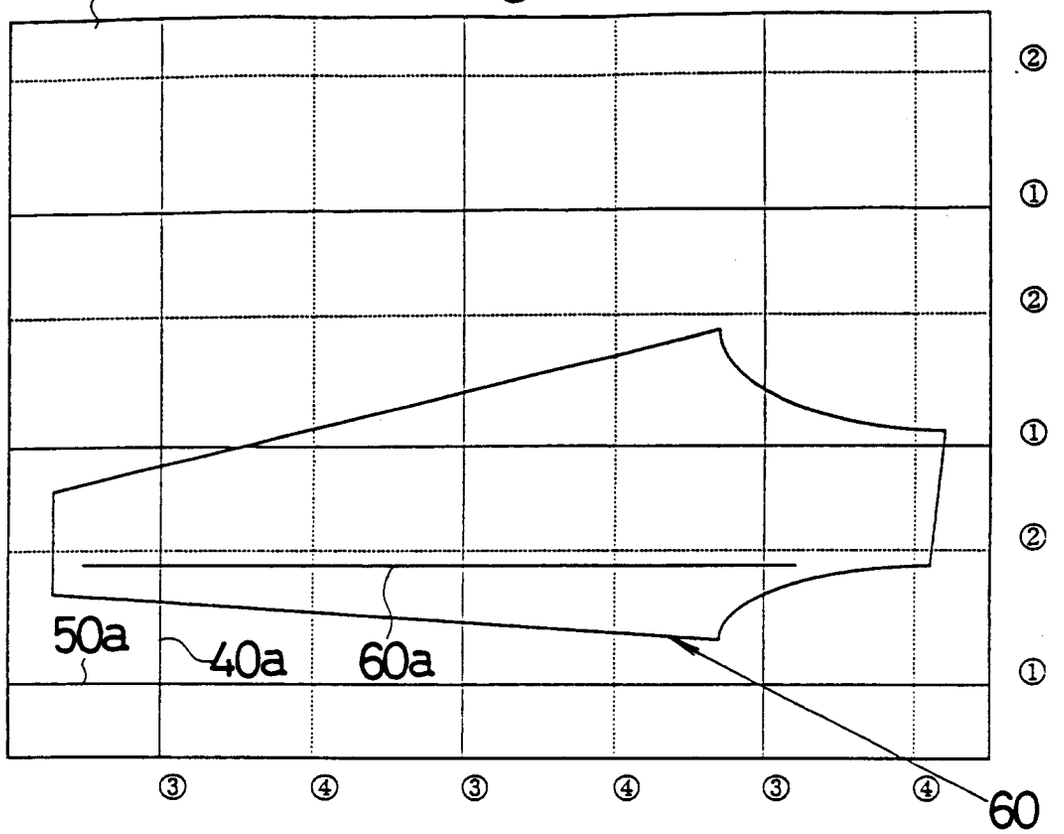
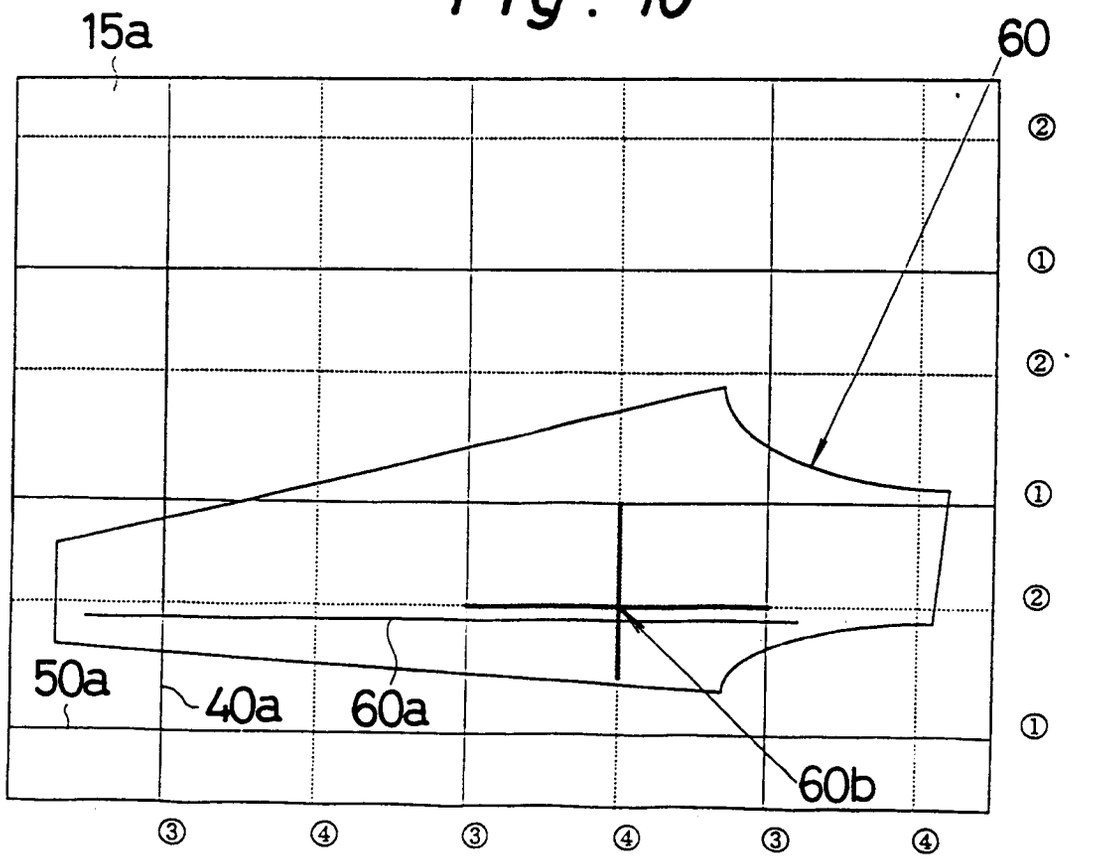

15a
②
①
②
①
②
①
50a
40a
60a
60
③
④
③
④
③
④

Fig. 10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60
②
①
②
①
②
①
50a
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60b
③
④
③
④
③
④

Fig. 11

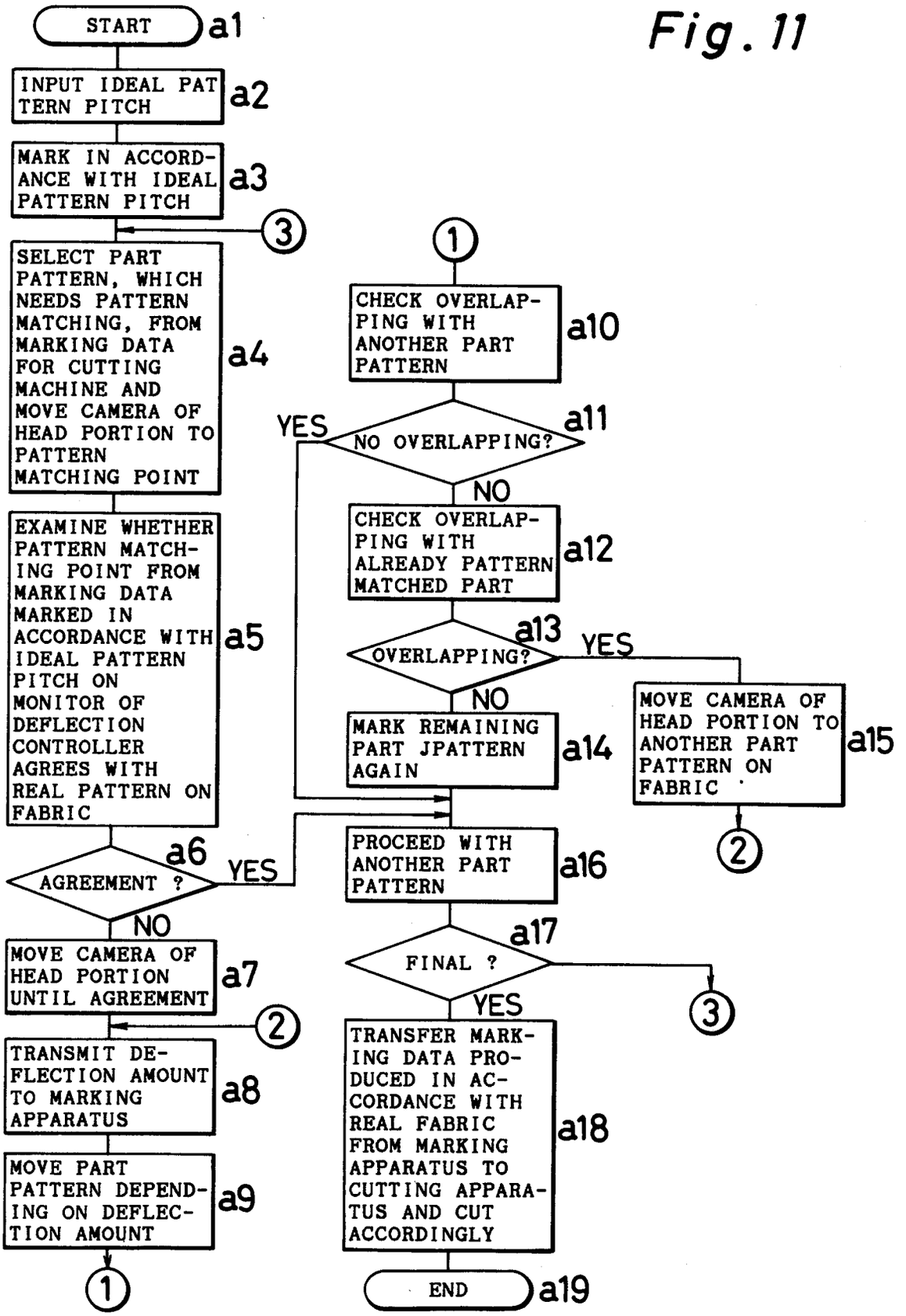
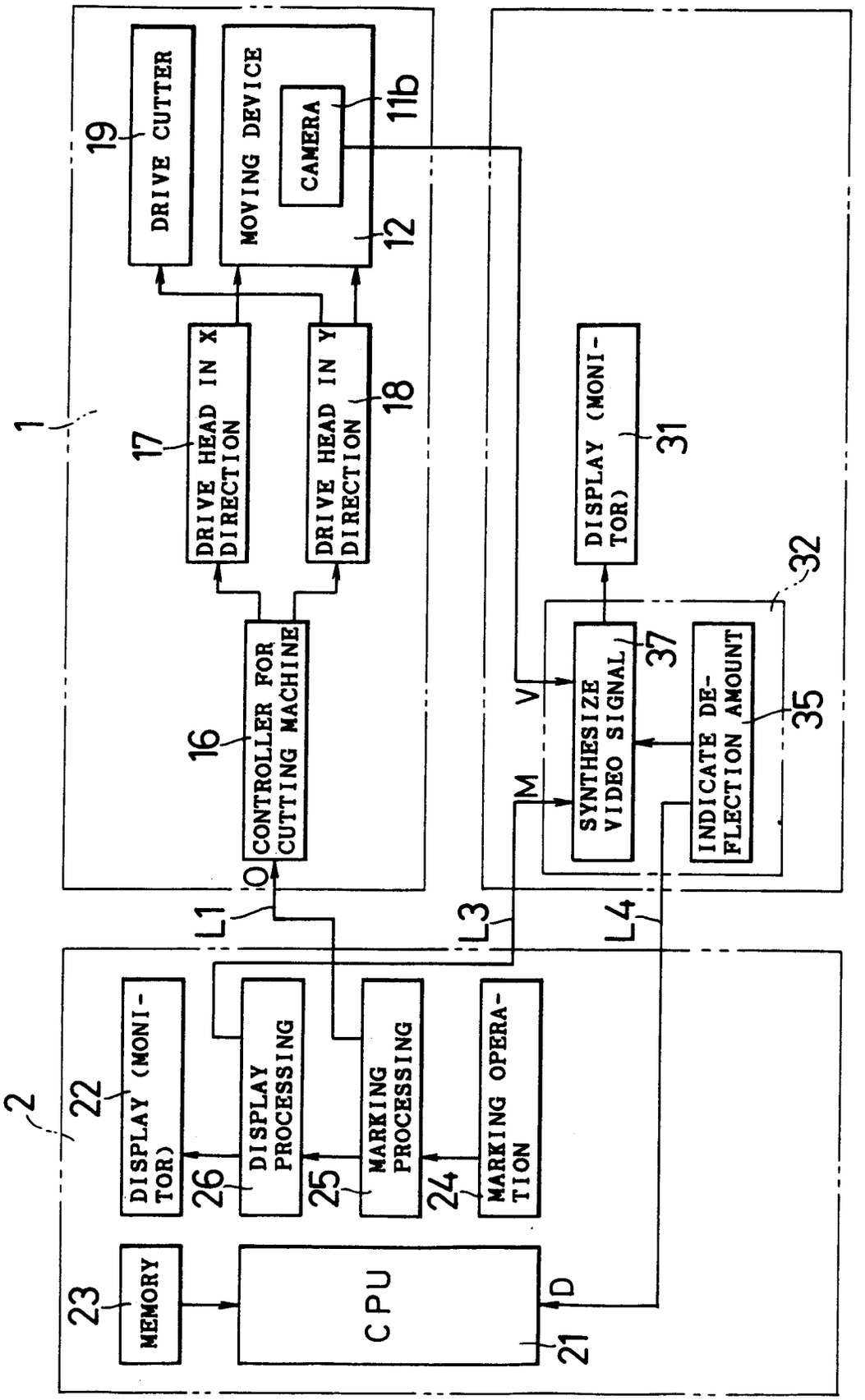

START
a1
INPUT IDEAL PAT TERN PITCH
a2
MARK IN ACCORD-ANCE WITH IDEAL PATTERN PITCH
a3
3
SELECT PART PATTERN, WHICH NEEDS PATTERN MATCHING, FROM MARKING DATA FOR CUTTING MACHINE AND MOVE CAMERA OF HEAD PORTION TO PATTERN MATCHING POINT
a4
EXAMINE WHETHER PATTERN MATCH-ING POINT FROM MARKING DATA MARKED IN ACCORDANCE WITH IDEAL PATTERN PITCH ON MONITOR OF DEFLECTION CONTROLLER AGREES WITH REAL PATTERN ON FABRIC
a5
AGREEMENT ?
a6
YES
NO
MOVE CAMERA OF HEAD PORTION UNTIL AGREEMENT
a7
2
TRANSMIT DE-FLECTION AMOUNT TO MARKING APPARATUS
a8
MOVE PART PATTERN DEPEND-ING ON DEFLEC-TION AMOUNT
a9
1
1
CHECK OVERLAP-PING WITH ANOTHER PART PATTERN
a10
YES
NO OVERLAPPING?
a11
NO
CHECK OVERLAP-PING WITH ALREADY PATTERN MATCHED PART
a12
OVERLAPPING?
a13
YES
NO
MARK REMAINING PART JPATTERN AGAIN
a14
MOVE CAMERA OF HEAD PORTION TO ANOTHER PART PATTERN ON FABRIC
a15
2
PROCEED WITH ANOTHER PART PATTERN
a16
FINAL ?
a17
3
YES
TRANSFER MARK-ING DATA PRO-DUCED IN AC-CORDANCE WITH REAL FABRIC FROM MARKING APPARATUS TO CUTTING APPARA-TUS AND CUT ACCORDINGLY
a18
END
a19

Fig. 12


1
2
19
DRIVE CUTTER
MOVING DEVICE
CAMERA
11b
12
17
DRIVE HEAD IN X DIRECTION
18
DRIVE HEAD IN Y DIRECTION
16
CONTROLLER FOR CUTTING MACHINE
O
L1
L3
L4
M
V
DISPLAY (MONITOR)
31
32
SYNTHESIZE VIDEO SIGNAL
37
INDICATE DEFLECTION AMOUNT
35
22
DISPLAY (MONITOR)
26
DISPLAY PROCESSING
25
MARKING PROCESSING
24
MARKING OPERATION
23
MEMORY
CPU
D
21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP93/00009

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^5 D06H7/00, 3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl^5 D06H7/00, 3/00-3/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho, 1926 - 1992
Kokai Jitsuyo Shinan Koho 1971 - 1992

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, B2, 2-46708 (Juki Corp.), October 17, 1990 (17. 10. 90), Claim; line 3, column 4, page 2 to line 27, column 11, page 6, drawings & DE, A1, 3831541	1-5
Y	JP, B2, 1-33587 (Investronica S. A.), July 13, 1989 (13. 07. 89), Claim; line 10, column 8, page 4 to line 29, column 16, page 8, drawings & EP, A3, 239685 & US, A, 4853866 & ES, A5, 553646 & DK, A, 384786 & FI, A, 863973	1-5
A	JP, A, 60-195407 (President and Fellows of Harvard College), October 3, 1985 (03. 10. 85), Claim; line 18, upper left column, page 3 to line 8, upper right column, page 5, drawings (Family: none)	1-5

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
March 31, 1993 (31. 03. 93)	April 20, 1993 (20. 04. 93)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP93/00009

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, A, 50-112556 (Kanegafuchi Chemical Industry Co., Ltd.), September 4, 1975 (04. 09. 75), Claim; line 12, upper left column, page 2 to line 6, upper left column, page 3, drawings (Family: none)	1-5