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(71) Applicant: **NV Michel van de Wiele**
8510 Kortrijk/Marke (BE)

(72) Inventor: **Debaes, Johny**
8890 Moorslede (BE)

(74) Representative: **Ostyn, Frans**
K.O.B. NV
Kennedypark 31 c
8500 Kortrijk (BE)

(54) Method and device for producing fabrics with cut pile with variable pile height

(57) This invention relates on the one hand to a double-face weaving machine comprising a cutting device (1) provided for cutting through a double-face fabric moving back and forth over the width of the weaving machine, said cutting device comprising one or more cutting knives (2,3) provided for cutting through the double-face fabric at least at a first and at a second cutting height. On the other hand this invention relates to a method for weaving pile fabrics with at least two different pile heights on such a double-face weaving machine.

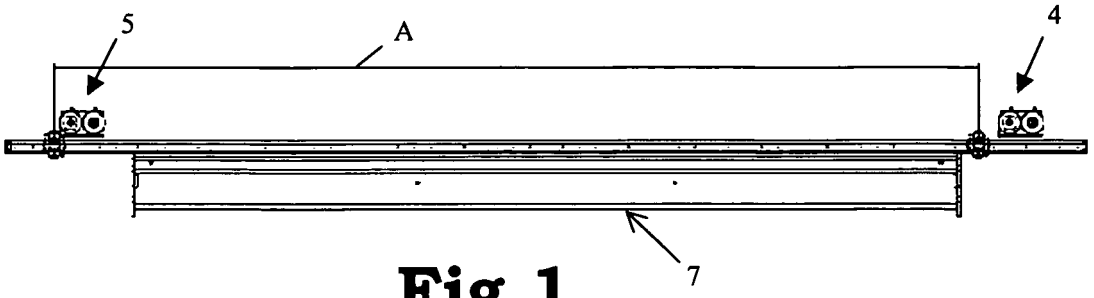

Fig. 1

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Description

[0001] This invention relates on the one hand to a double-face weaving machine comprising a cutting device provided for cutting through a double-face fabric moving back and forth over the width of the weaving machine, said cutting device comprising one or more cutting knives provided for cutting through the double-face fabric at least at a first and/or at a second cutting height. On the other hand this invention relates to a method for weaving pile fabrics with at least two different pile heights on such a double-face weaving machine.

[0002] A strong trend is noticeable towards the production of pile fabrics with different structures within the same fabric. The European patent publication EP 1 347 087, for example, describes a method and a device for producing fabrics having a wide variety of structures using the double-face weaving technique. Practically unlimited combinations of cut pile with loops and with pattern-forming pile warps that float over one or more wefts before being bound ("flat weave") can be produced. Another method is described in the British patent publication GB 346 107. The method described allows pile of different heights to be woven into a fabric by double-face weaving by allowing pile yarns for the longer pile to float over a number of wefts on the pile side and then to bind them over a weft on the pile side before moving to the other ground fabric so that after cutting through the pile this latter pile can be released from this weft with a limited force by means of a scraping operation on the carpet so that a longer pile yam is produced than is the case with the normal pile fabric production. In view of the significant number of wefts over which the pile has to be bound, the same technique can be employed to produce high pile with a limited density. Furthermore, an additional scraping operation is necessary.

[0003] The American patent publication US 3 406 725 in turn describes how on a double-face weaving machine the pile height can be varied from cycle to cycle by allowing the cutting knife to operate at a different height so that height differences in the pile occur on both fabrics of the double-face fabric that are complementary: where in the lower fabric a row with short pile is produced, a pile row with longer pile is produced in the upper fabric. For this, either different cutting knives can be installed in the cutting area, the height of the cutting knife guide can be moved or the upper and/or lower ruler can be moved relative to the cutting knife. In view of the high mass of an upper or lower straightedge and cutting knife guide, the solutions with movement of upper or lower ruler or cutting knife guide should be avoided in order to carry out these movements at high operating speeds. The movement of the cutting knife in its holder or the changing between cutting knives at different working heights is a more practicable solution.

[0004] Cutting knives at different heights represent a problem for the regrinding. One of the advantages of double-face weaving is specifically that the cutting knife is ground after every cutting movement by moving it along a grinding device on its run-out stroke. US 3 406 725 offers no solution for efficiently regrinding the cutting knives that cut through the double-face fabric at varying heights in each movement cycle of the cutting knife.

[0005] The object of this invention is therefore to create a method and device that allows one or more cutting knives to be employed on a double-face weaving machine on which fabrics are produced with cut pile with different pile heights, and that these cutting knives can be reground during the weaving process.

[0006] The object of the invention is achieved by providing on a double-face weaving machine comprising a cutting device provided for cutting through a double-face fabric moving back and forth over the width of the weaving machine, said cutting device comprising one or more cutting knives provided for cutting through the double-face fabric at least at a first and at a second cutting height, said weaving machine comprising at least two grinding devices for a cutting knife, said grinding devices each being at different working heights to grind the cutting knife. This type of weaving machine has the advantage that both the cutting knife provided for cutting through the double-face fabric at a first cutting height and the cutting knife provided for cutting through the double-face fabric at a second cutting height can be reground during the weaving process.

[0007] Within the context of this patent description the term working height of the grinding device is used to refer to the position of the grinding device in which the grinding device is able to grind a cutting knife that cuts at a given cutting height.

[0008] The inventive double-face weaving machine comprises in a first preferred embodiment three grinding devices of which at least two grinding devices are each at a different working height.

[0009] In a second preferred embodiment the inventive double-face weaving machine comprises four grinding devices of which at least two grinding devices are each at a different working height. In particular the four grinding devices are each at a different working height.

[0010] In accordance with a preferred embodiment of the inventive double-face weaving machine at least two grinding devices are provided on opposite sides of the weaving machine.

[0011] In a more preferred embodiment of the inventive double-face weaving machine the cutting device is controlled by a path-controlled actuator for execution of its back and forth movement. This type of actuator serves to define the different movement paths of the cutting device, depending on the height of the active cutting knife and the location of the grinding device with the corresponding working height. A path-controlled actuator offers the possibility of defining at each cutting cycle the path to be travelled from the current position on the basis of the height of the active cutting knife and the adjustment of the different grinding devices.

[0012] Defining the path to be travelled means at least

the end point of this path, but the definition of the path generally also includes information on the time when intermediate positions have to be reached and/or the speed and/or the acceleration with which the movement to each of these positions has to be performed.

[0013] In a more particular embodiment of the double-face weaving machine the cutting device comprises a cutting head with a rotatable part, said part having a first cutting knife for cutting through the double-face fabric at a first cutting height and a second cutting knife for cutting through the double-face fabric at a second cutting height and said part being provided to move a cutting knife by rotation into a position in which it cuts through the double-face fabric. Switching over from the one cutting height to the other cutting height is effected by a rotational movement of a part of the knife holder.

[0014] In another particular embodiment of the double-face weaving machine the cutting device comprises a height-adjustable cutting knife.

[0015] Another subject of this invention relates to a method for weaving of pile fabrics with at least two different pile heights on a double-face weaving machine in which in consecutive insertion cycles weft yarns are inserted between ground warp yarns and pile-warp yarns so that two ground fabrics are woven above one another, with the weaving machine also having a cutting device comprising one or more cutting knives moving back and forth over the width of the weaving machine provided for cutting through the formed double-face fabric at least at a first and at a second cutting height, and in which the cutting knife for cutting through at a first cutting height is ground on a first grinding device and the cutting knife for cutting through at a second cutting height is ground on a second grinding device, said grinding devices each being at a different working height.

[0016] According to a preferred method the cutting height can be changed at least at one position between the fabric and one of the grinding devices during a weaving cycle. This invention is now explained in greater detail by reference to the following detailed description of an inventive double-face weaving machine and a method for weaving pile fabrics with at least two different pile heights on such a double-face weaving machine. The intention of this description is exclusively to give an explanatory example and to indicate further advantages and special features of this invention and can therefore in no way be interpreted as a limitation of the field of application of the invention or of the patent rights claimed in the claims.

[0017] In this detailed description, reference is made by means of reference numbers to the attached drawings, in which:

- *Figures 1 and 2 show schematically the cutting device of a double-face weaving machine with a grinding device on opposite sides, where the grinding device on the left-hand side is adjusted for grinding the cutting knife in the highest (second) position and the grinding device on the right-hand side is adjusted for grinding the cutting knife in the lowest (first) position;*
- *Figure 3 is a detailed representation of a cutting knife provided for cutting a double-face fabric at a second cutting height;*
- *Figure 4 is a detailed representation of a cutting knife provided for cutting a double-face fabric at a first cutting height;*
- *Figure 5 is a representation of a reciprocating knife holder comprising a first and a second cutting knife*.

[0018] On a double-face weaving machine, two ground fabrics are woven above one another with one or more wefts being inserted at the same time into sheds located above one another. These ground fabrics are joined by pile-warp yarns. On the weaving machine these pile-warp yarns are cut through by a cutting device (1) moving back and forth over the width of the weaving machine so that ultimately a top and bottom fabric is formed. The cutting device (1) of a double-face weaving machine consists of a knife carriage or cutting carriage with one or more cutting knives mounted on the carriage in which the knife carriage or cutting carriage moves back and forth over a guide in weft direction on a cutting bench on the double-face weaving machine and a drive to drive the movement of the knife carriage or cutting carriage.

[0019] In order to now obtain pile fabrics with at least two different pile heights the cutting device (1) has one or more cutting knives (2,3) provided for cutting through the double-face fabric at least at a first and/or a second cutting height. The cutting through at a first or a second cutting height can be performed with a cutting knife (2,3) that is adjustable in height or by changing between cutting knives that cut at either a first cutting height or at a second cutting height in the cutting area. Figure 5 is a representation of a knife holder (6) having a first (2) and a second (3) cutting knife provided for cutting through a double-face fabric at a first and a second cutting height respectively. The switching over from the one cutting height to the other cutting height is effected by a rotational movement of a part of the knife holder (6).

[0020] In order to now be able to regrind the above-mentioned cutting knives (2 and 3) during the weaving process, the weaving machine has at least two grinding devices (4,5) for a cutting knife, said grinding devices (4,5) each being at a different working height in order to grind the cutting knife (2,3). The grinding devices (4,5) are installed as shown in Figures 1 and 2 at the height of the run-out sides of the cutting movement. The cutting movement is performed by the cutting device (1), the run-out sides are regarded as the part of the cutting movement over which the cutting knife travels from the position where it leaves this fabric at one of the sides of the formed double-face fabric (7) until the end of the travel.

[0021] Grinding can be carried out on the one hand by controlling the carrier of the cutting knife in such a way that it passes along the grinding device (4,5) only on the

run-out side where the grinding device (4,5) is positioned at the appropriate working height defined by the active cutting knife and by limiting its movement on the run-out side where the grinding device (4,5) is not positioned at the appropriate working height defined by the active cutting knife until in front of the grinding device (4,5), or on the other hand by controlling the height adjustment of the cutting knife in such a way that the active cutting knife on its passage past one of the grinding devices (4,5) is adjusted to the correct height, or by a combination of the two methods.

[0022] The method according to this invention is explained by reference to Figures 1 and 2, where in Figure 1 the movement path (A) is illustrated for the knife carriage with the cutting knife (3) adjusted for cutting through a double-face fabric at the second cutting height. This movement path (A) starts on the right between the fabric (7) and a first grinding device (4) for grinding the cutting knife (2) for cutting through the double-face fabric at the first cutting height and extends over a second grinding device (5) provided for grinding the cutting knife (3) for cutting through the double-face fabric at the second cutting height. Over this path (A) the cutting knife (3) has cut through the double-face fabric at the second (highest) cutting height and the corresponding second cutting knife (3) has been reground at this cutting height.

[0023] If the cutting knife is to cut again at the same height in the following cycle it can move out of this position and move to the position on the right-hand side as shown in Figure 1 (between the first grinding device (4) and the fabric (7)). On this side it cannot be ground in this condition. It is possible during the following weaving cycle in the period when cutting is not required (shed formation and weft insertion) to change the height of the cutting knife to the first (lowest) position and then to move the cutting knife (2) provided for cutting through the double-face fabric at the first cutting height along the first grinding device (4) and:

- if during the following movement the cutting device is to cut at the first cutting height, it can move from this position for the following cutting movement;
- if, on the other hand, the cutting device is to cut at the second cutting height during the following movement, the cutting knife can be first moved back along the first grinding device (4) to a position between this grinding device (4) and the double-face fabric (7) and can then return to the highest position (second cutting height of the cutting knife);
- even if the cutting device is to cut at the first cutting height the cutting device can already be moved back along the first grinding device (4) and come to a standstill in a position between the grinding device (4) and the double-face fabric (7) to wait for the moment to start its cutting movement with the cutting knife (2) for cutting through the double-face fabric at the first cutting height.

[0024] Figure 2 shows the movement path (B) for the measuring carriage with the cutting knife (2) adjusted for cutting through a double-face fabric at the first cutting height. This movement path (B) starts on the left between the fabric (7) and the second grinding device (5) for grinding the cutting knife (3) for cutting through the double-face fabric at the second cutting height and extends over the first grinding device (4). Over this path (B) the cutting knife (2) has cut through the double-face fabric at the first (lowest) cutting height and the corresponding first cutting knife (2) has been reground at this cutting height.

[0025] If the cutting knife is to cut again at the same height in the following cycle it can move out of this position and move to the position on the left-hand side as shown in Figure 2 (between the second grinding device (5) and the fabric (7)). On this side it cannot be ground in this condition. It is possible during the following period in the weaving cycle when cutting is not required (shed formation and weft insertion) to change the height of the cutting knife to the second (highest) position and then to move the cutting knife (3) provided for cutting through the double-face fabric at the second cutting height along the second grinding device (5) and:

- if during the following movement the cutting device is to cut at the second cutting height, it can move from this position for the following cutting movement;
- if during the following movement the cutting device is to cut at the first cutting height, the cutting knife (3) can be first moved back along the second grinding device (5) to a position between this grinding device and the double-face fabric and can then return to the lowest position (first cutting height of the cutting knife);
- even if the cutting device is to cut at the second cutting height the cutting device can already be moved back along the second grinding device and come to a standstill in a position between the grinding device and the double-face fabric to wait for the moment to start its cutting movement with the cutting knife for cutting through the double-face fabric at the second cutting height.

[0026] With this method the movement of the cutting knife within a weaving cycle can thus comprise a combination of movements from the following series:

1) movement from a position between a first grinding device (4) and the double-face fabric (7) where the cutting knife can change its cutting height, along this first grinding device (4) to the end of the movement path;
2) movement from this end of the movement path along the first grinding device (4) at the first height to a position where the cutting knife is located between the grinding device and the double-face fabric and where it can change its cutting height;
3) movement along the double-face fabric (7) during

which the double-face fabric is cut through at the height determined by the height position of the active cutting knife from a position between the one grinding device and the double-face fabric and a position between the other grinding device and the double-face fabric, whereby both positions allow the cutting knife to change its cutting height;

3') the reverse movement to that described under point 3;

4) movement along a second grinding device (5) from a position where the cutting knife is located between the grinding device (5) and the double-face fabric (7) and where it can change its cutting height and the end of the movement path;

5) movement from this position at the end of the movement path along this second grinding device to a position between this second grinding device and the double-face fabric where the cutting knife can change its cutting height.

[0027] The invention covers all the methods:

- in which the first (4) and second (5) grinding device are adjusted to each regrind the cutting knife at a different working height;
- and whereby the device is provided to change the height of the cutting knife during a weaving cycle at least at one position between the fabric (7) and one of the grinding devices (4,5);
- and whereby in a first weaving cycle at least the movements 1, 2 and 3 are performed and in a further weaving cycle at least the movements 3, 4 and 5 are performed;
- and whereby seen over consecutive weaving cycles a cutting device moves along both grinding devices to regrind cutting knives;
- and whereby the control of the movements is provided so that a movement along a grinding device (movement 1, 2, 4 and 5) is only possible when the cutting knife has been brought into the working position at the correct cutting height.

[0028] Typical consecutive weaving cycles according to the invention are:

Movement: 1 - 2 - 3 - 4 - 5 - 3' - 1 - 2 - 3 - 4- 5 - 3'

[0029] Following this sequence of movements, a pile row is cut alternately at a first cutting height and a pile row at a second cutting height. The change in the cutting height of the cutting knife can hereby take place just before the movements 3 or just after the movements 3; the cutting height of the active cutting knife during the movements 1, 2 , 4 or 5 must hereby naturally correspond to the height at which the grinding device which the cutting device is to pass is set.

[0030] If several consecutives pile rows are to be cut at the same cutting height, then the movements in these consecutive weaving cycles can be limited to 1 - 2 - 3 - 3' - 1 - 2 - 3.

[0031] During these weaving cycles the height of the cutting knife does not have to be adjusted or changed, but the cutting knife is only reground every 2 cutting movements (once forward and once back).

[0032] In order to be able to still make every cutting movement with a reground cutting knife for several pile rows at the same cutting height if the same cutting knife can be moved to different heights, the following sequence of movements can be applied:

1 - 2 - 3 - 4 - 5 - 3' - 1 - 2 - 3 - 4- 5 - 3'

provided that in this sequence of movements the height of the cutting knife can be changed or the cutting knife can be changed in each cycle between movements 3 and 4 and between movements 5 and 1.

[0033] Seen from the above-mentioned cases, the sequence of movements 1 - 2 - 3 - 4 - 5 - 3' - 1 - 2 - 3 - 4- 5 - 3' appears to be universally applicable in each weaving cycle if the height of the cutting knife can be changed, then a fixed coupling of movements with the main axis can also be employed in place of a path-controlled actuator e.g. by means of a cam-controlled coupling but then in combination with a freely selectable control for changing the height of the cutting knife. Freely selectable is understood here as meaning that at a limited number of positions of the cutting knife, a change in cutting height can be carried out or not. However an independently controllable actuator can equally be employed here that performs a change in height of the cutting knife synchronously in time, synchronously in angle with the main shaft or synchronously in position with the cutting knife.

[0034] These sequences of movements are given simply as examples. It goes without saying that other combinations are possible that also form part of the scope of protection of this invention.

[0035] The path-controlled actuator for driving the cutting knife is preferably a servo motor. Such motors have a position feedback system that allows the preset movement path to be maintained with a preset accuracy.

[0036] The path-controlled actuator is coupled to the cutting knife carrier. Preferred embodiments of such couplings are known from prior art, such as drive drums rotating back and forth which drive a rope or toothed belt that is connected at both ends to the cutting knife carrier, recirculating ball screws that are connected to the cutting knife carrier, or the path-controlled actuator can be a linear motor of which one or more elements are connected to or form part of the cutting knife carrier.

[0037] In the event that the cutting device is equipped with cutting knives at more than two working heights the grinding device can be equipped with an electromechanical, pneumatic, magnetic or hydraulic device for adjustment of the height so that when an active cutting knife arrives at a certain working height, one of the grinding devices on one side of the weaving machine can be ad-

justed to the correct height.

[0038] A preferred method also consists in also defining the movement path for the cutting knife carrier and/or the height adjustment of the grinding devices as a function of the pattern to be woven when creating the program for the control of the shed formation (dobby or jacquard) for each weft insertion.

This information allows the controller of the weaving machine to control the drive motor for the cutting movement in the desired manner and also the drive for the height adjustment of the grinding devices, if installed.

Claims

1. Double-face weaving machine comprising a cutting device (1) provided for cutting through a double-face fabric moving back and forth over the width of the weaving machine, said cutting device comprising one or more cutting knives (2,3) provided for cutting through the double-face fabric at least at a first and at a second cutting height, **characterised in that** the weaving machine comprises at least two grinding devices (4,5) for a cutting knife, said grinding devices (4,5) each being at different working heights to grind the cutting knife.

2. Double-face weaving machine according to Claim 1, **characterised in that** the weaving machine comprises three grinding devices of which at least two grinding devices are each at a different working height.

3. Double-face weaving machine according to Claim 1, **characterised in that** the weaving machine comprises four grinding devices of which at least two grinding devices are each at a different working height.

4. Double-face weaving machine according to Claim 3, **characterised in that** the four grinding devices are each at a different working height.

5. Double-face weaving machine according to one of the preceding claims, **characterised in that** at least two grinding devices are provided on opposite sides of the weaving machine.

6. Double-face weaving machine according to one of the preceding claims, **characterised in that** the cutting device (1) is controlled by a path-controlled actuator for execution of its back and forth movement.

7. Double-face weaving machine according to one of the preceding claims, **characterised in that** the cutting device (1) comprises a cutting head (6) with a rotatable part (8), said part (8) having a first cutting knife (2) for cutting through the double-face fabric at a first cutting height and a second cutting knife (3) for cutting through the double-face fabric at a second cutting height and said part (8) being provided to move a cutting knife (2,3) by rotation into a position in which it cuts through the double-face fabric.

8. Double-face weaving machine according to one of Claims 1 to 6, **characterised in that** the cutting device (1) comprises a height-adjustable cutting knife.

9. Method for weaving pile fabrics with at least two different pile heights on a double-face weaving machine in which in consecutive insertion cycles weft yarns are inserted between ground warp yarns and pile-warp yarns so that two ground fabrics are woven above one another, with the weaving machine also having a cutting device (1) comprising one or more cutting knives (2,3) moving back and forth over the width of the weaving machine provided for cutting through the formed double-face fabric at least at a first and at a second cutting height, **characterised in that** the cutting knife (2) for cutting through at a first cutting height is ground on a first grinding device (4) and the cutting knife (3) for cutting through at a second cutting height is ground on a second grinding device (5), said grinding devices (4,5) each being at a different working height.

10. Method according to Claim 9, **characterised in that** the cutting height can be changed at least at one position between the fabric and one of the grinding devices during a weaving cycle.

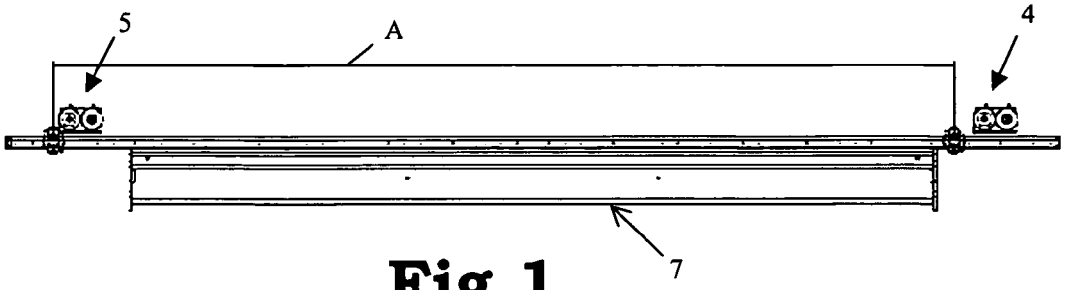

Fig.1

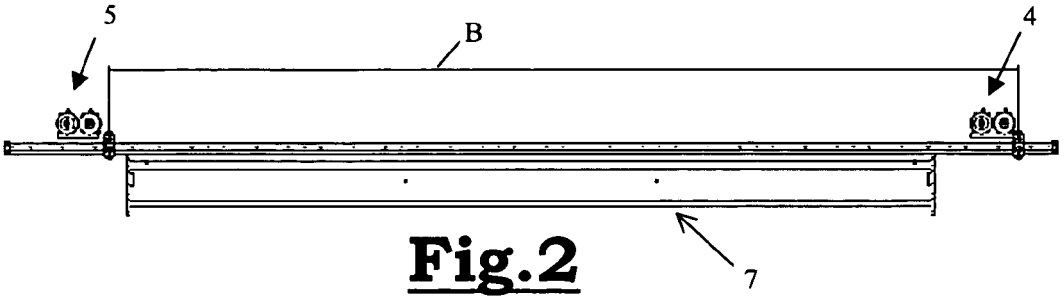

Fig.2

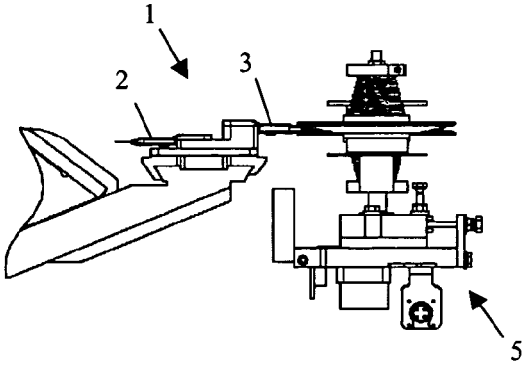

Fig.3

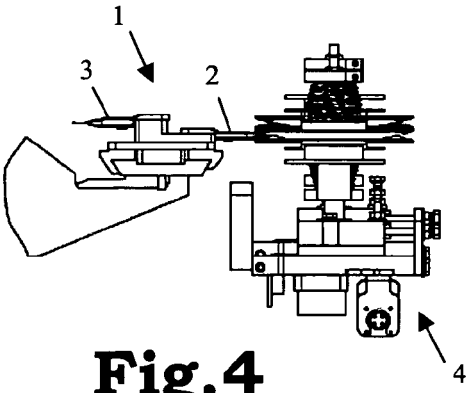

Fig.4

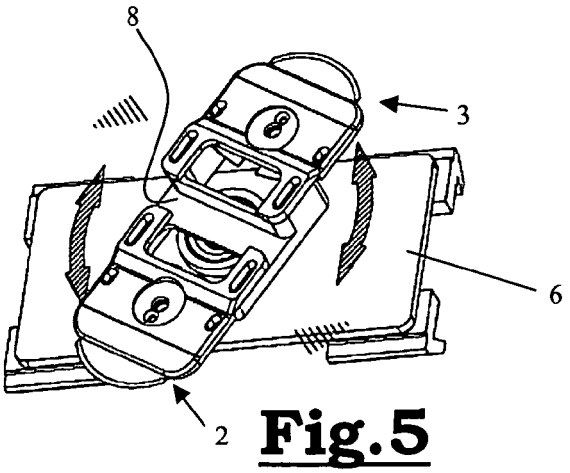

Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 0527

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	US 3 406 725 A (HUBERT HASTEWELL CLAUDE ET AL) 22 October 1968 (1968-10-22) * column 1, line 52 - column 2, line 7 * * column 5, lines 5-29; figures 1-5 * -----	1-10	INV. D03D39/18
A	EP 1 394 301 A (SCHOENHERR TEXTILMASCHB GMBH [DE]) 3 March 2004 (2004-03-03) * paragraphs [0058], [0061] - [0063], [0066] - [0069]; figures 1-15 * -----	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 November 2009	Louter, Petrus

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 16 0527

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10-11-2009

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- US 3406725 A **[0003] [0004]**