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(54) **DEVICE AND METHOD FOR PRODUCING FABRIC WITH LENO CONSTRUCTION**

(57) The present invention relates to device for producing fabric with leno construction, which device comprises a first and second slot holder and a needle holder, the first slot holder comprising a first oblique slot and the second slot holder a second oblique slot, wherein the first and the second oblique slot overlap, wherein the first and the second slot holder are movable relative to each other between a first and a second extreme position, wherein in

an intermediate position between the first and the second extreme position the first and the second oblique slot form a cross, wherein in the first extreme position a first end of the first oblique slot and a first end of the second oblique slot overlap, wherein in the second extreme position a second end of the first oblique slot overlaps with a second end of the second oblique slot.

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Description

FIELD OF THE INVENTION

[0001] The present invention pertains to the technical field of weaving machines and looms, more specifically to devices and methods for producing fabric with leno construction.

BACKGROUND

[0002] Leno weave, also called gauze weave or cross weave, is a weave in which two warp yarns are twisted around the weft yarns to provide a strong yet sheer fabric. The standard warp yarn is paired with a skeleton or 'doup' yarn; these twisted warp yarns grip tightly to the weft which greatly increases the durability of the fabric. Leno weave produces a fabric with almost no yarn slippage or misplacement of threads.

[0003] The known methods for producing a leno construction on a fabric are especially suited to create said leno structure at the edge of said fabrics. Such methods require the use of an orifice through which a warp thread passes before reaching a plate element configured to laterally shift said warp between two positions adjacent to at least a second warp held by a needle. Such an arrangement is bulky, complex, and often fail to properly shift warp threads. Furthermore, such devices are not well suited to create said leno structure anywhere between the edges of the fabric, thus being limited in their applicability.

[0004] The aim of the invention is to provide a method which eliminates those disadvantages.

SUMMARY OF THE INVENTION

[0005] The present invention and embodiments thereof serve to provide a solution to one or more of above-mentioned disadvantages. To this end, the present invention relates to device for producing fabric with leno construction according to claim 1. The device makes use of two slot holders and a needle holder in order to ensure reliable lateral displacement of at least one warp yarn, and in this way overcome the limitations of devices known in the art.

[0006] Preferred embodiments of the device are shown in any of the claims 2 to 12. A specific preferred embodiment relates to an invention according to claim 6, wherein an embodiment of the device permits the creation of more robust three yarn lenos.

[0007] In a second aspect, the present invention relates to a method for producing fabric having at least one leno construction according to claim 13. The method is advantageous because it ensures reliable lateral displacement of at least one warp yarn.

[0008] Preferred embodiments of the method are shown in any of the claims 14 to 15.

DESCRIPTION OF FIGURES

[0009] The following description of the figures of specific embodiments of the invention is merely exemplary in nature and is not intended to limit the present teachings, their application or uses. Throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

Figure 1 schematically presents a device according to the invention configured to produce a two yarn leno.

Figure 2 show a side view of the device of **Figure 1**.

Figure 3 schematically presents a device according to the invention configured to produce a three yarn leno.

Figure 4 schematically presents a device according to the invention configured to simultaneously produce two lenos on each of two layers of woven material.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

[0011] As used herein, the following terms have the following meanings:

"A", "an", and "the" as used herein refers to both singular and plural referents unless the context clearly dictates otherwise. By way of example, "a compartment" refers to one or more than one compartment.

[0012] "Comprise", "comprising", and "comprises" and "comprised of" as used herein are synonymous with "include", "including", "includes" or "contain", "containing", "contains" and are inclusive or open-ended terms that specifies the presence of what follows e.g. component and do not exclude or preclude the presence of additional, non-recited components, features, element, members, steps, known in the art or disclosed therein.

[0013] Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order, unless specified. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0014] The recitation of numerical ranges by endpoints includes all numbers and fractions subsumed within that range, as well as the recited endpoints.

[0015] Whereas the terms "one or more" or "at least

one", such as one or more or at least one member(s) of a group of members, is clear *per se*, by means of further exemplification, the term encompasses *inter alia* a reference to any one of said members, or to any two or more of said members, such as, e.g., any ≥ 3 , ≥ 4 , ≥ 5 , ≥ 6 or ≥ 7 etc. of said members, and up to all said members.

[0016] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to a person skilled in the art from this disclosure, in one or more embodiments. Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

[0017] In the context of the present invention, 'warp thread' denotes a type of thread that is held stationary in tension on a frame or loom while the weft thread is drawn through and inserted over-and-under the warp. The terms yarn and thread are used throughout the document, and are to be understood as interchangeable terms.

[0018] In a first aspect, the invention relates to A device for producing fabric with leno construction.

[0019] The device comprises:

- at least one needle holder movable in a vertical direction, with a vertical needle, for the guidance of a first warp thread; and
- a set of two slot holders movable in a vertical direction for the guidance of a second crossing warp thread, wherein a first slot holder comprises a first oblique slot.

[0020] The device is further provided with a second slot holder comprising a second oblique slot, which first oblique slot and the second oblique slot overlap. The first slot holder and the second slot holder are movable relative to each other between a first extreme position and a second extreme position, wherein in an intermediate position between the first extreme position and the second extreme position the first oblique slot and the second oblique slot form a cross. In the first extreme position, a first end of the first oblique slot and a first end of the second oblique slot overlap. In the second extreme position a second end of the first oblique slot, opposite to the first end of the first oblique slot, overlaps with a second

end of the second oblique slot, opposite to the first end of the first oblique slot. The overlapping slots of the slot holders form a narrow channel through which the second warp yarn is passed. The movement of one of the slot holders relative to the other cause said channel to be displaced laterally, thereby guaranteeing also the lateral displacement of the second warp yarn.

[0021] The needle holder is movable between a third extreme position and a fourth extreme position. In the third extreme position the needle blocks a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder. In the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder. The first warp thread and the second warp thread maintain a same relative position in a vertical direction.

[0022] The device permits a reliable formation of a leno structure in the piece being woven because the overlapping oblique slots force the second warp thread to move from the first end to the second end of the oblique slots and back.

[0023] In an embodiment, each slot holder is fitted on a track secured to the main frame of a loom, each holder being moved by means of a rack and pinion mechanism, the rack of a first slot holder of each set of two slot holders being moved by a first pinion, the rack of the at least one needle holder and the rack of the of each second slot holder of each set of two slot holders are moved by the same pinion such that said needle holder is 180 degrees out of phase relative to said second slot holder. In this way, both slot holders can be independently moved relative to each other, while dispensing the need to have three independent pinions and three different actuation means. This allows the device to have an even more compact construction, greatly expanding the placement possibilities of the device to other than the edges of the woven product. With the device according to the invention, it is advantageously possible to crate leno structures anywhere in the woven product.

[0024] In an embodiment, the higher position of the first slot holder is at least 5mm higher relative to the position of the second slot holder, and the lower position of the first slot holder is at least 5mm lower relative to the position of the second slot holder. By preference, the first and second slot holders are movable relative to each other at least 80%, more preferably at least 90% of the height of the slot and most preferably at least 95% of the height of the slot. The height of the slot is measured in a vertical direction from the first end to the second end of the slot. In this way, the first and second slot holders are sufficiently movable to permit reliably shifting the warp yarn laterally and without the risk of creating shear forces on said warp yarn, thus preventing stoppages and lost production time due to broken yarns.

[0025] In an embodiment, the each pair of holders is interposed by a plate of a low friction material, said plate

comprising a slot configured to permit the passage of yarn while each of the slot holder is at or between a first extreme position and a second extreme position. This low friction material may be a lubricant impregnated metal, nonferrous metal alloy or plastic. By preference said low friction material is oil impregnated bronze, polytetrafluoroethylene (PTFE), polyacetal (POM), most preferably, said low friction material is POM. In this way, friction and consequently heat are advantageously reduced, which eliminates the risk of fire should any yarn fibers reach between any of the holders. The reduced friction aids also in extending the useful life of the device and reduce energy consumption.

[0026] In an embodiment, each slot holder comprises two oblique slots placed at different heights. The first ends of both oblique slots of a slot holder are vertically aligned with each other. The second ends of both oblique slots of a slot holder are vertically aligned with each other. In the third extreme position the needle blocks a passage for the second crossing warp thread between the first and second ends of the oblique slots at different heights of each slot holder. In the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the oblique slots at different heights of each slot holder.

[0027] This permits crating a three yarn leno. By preference, said oblique slots are disposed symmetrically to each other about a top plane located between said both slots. In this way, the three yarn leno advantageously further increases the resistance offered by the warp yarns to any slippage of the weft, thus producing increased resistance to fraying.

[0028] In an embodiment, each slot holder comprises at least two oblique slots disposed side-by-side at the same height, the oblique slots of a slot holder being substantially parallel to each other, and the needle holder comprising a needle for each of the at least two oblique slots, each needle being vertically positioned at an intermediate position between the first end and the second end of its corresponding oblique slot. In the third extreme position each needle blocks a passage for the second crossing warp thread between the first and second ends of the corresponding oblique slots of the first slot holder and the second slot holder. In the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the corresponding oblique slots of the first slot holder and the second slot holder.

[0029] This permits crating multiple two yarn lenos on a same plane. These same plane lenos are quite advantageous when located between adjacent portions of woven material as said lenos advantageously prevent fraying of the edges of each of said portions even after the fabric is cut between said lenos.

[0030] It is clear that multiple slots can be disposed side-by-side at the same height. It is clear that in this way the whole width of a loom can be used in order to create lenos.

[0031] In an embodiment, the needle holder comprises a longitudinal slot configured to permit the passage of yarn while each of the slot holders is at or between a first extreme position and a second extreme position. This slot advantageously allows for longer needle holders without hindering the passage of yarn through the oblique slots of the slot holders. The additional length of the needle holders permits supporting said needle holders near both ends by means of two tracks. This results in increased stability and precision of motion of the needles. The slot permits also the use of a single needle holder to support at least two opposing needles, one near the top of the slot and another at the bottom of the same slot. It will be obvious for one skilled in the art that these advantages compound into a substantial increase in the flexibility of the device.

[0032] In an embodiment, each slot holder comprises a first set of oblique slots and a second set of oblique slots, said second set being vertically aligned with said first set, each set comprising one or two oblique slots, the needle holder further comprising at least two vertically aligned needles directed opposite to each other and being aligned with each vertically aligned first and second set of oblique slots. In the third extreme position a first needle blocks a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and a second needle clears a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder. In the fourth extreme position the first needle clears a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and the second needle blocks a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder.

[0033] This advantageously permits creating at least two leno structures simultaneously in two different layers of a double weave. By providing two opposing needles in the same needle holder for each number of vertically aligned oblique slots, two vertically aligned lenos are produced with little to no increase in energy consumption since no further actuators are required to move both needles.

[0034] In an embodiment, each slot holder comprises a first set of oblique slots and a second set of oblique slots, said second set being vertically aligned with said first set, each set comprising one or two oblique slots, the device further comprising a first needle holder and a second needle holder, each needle holder comprising at least one needle, said needle of the first needle holder being vertically aligned and directed opposite to the needle of the second needle holder, each pair of opposed needles being aligned with each vertically aligned first and second set of oblique slots. The first needle holder and the second needle holder are movable between a third ex-

treme position and a fourth extreme position. In the third extreme position said needle of the first needle holder blocks a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and said needle of the second needle holder blocks a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder. In the fourth extreme position said needle of the first needle holder clears a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and said needle of the second needle holder clears a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder. Preferably the first needle holder and the second needle holder are configured to move in opposite directions.

[0035] The use of separate needle holders moving in opposite directions presents a number of advantages, none the least is the balancing of vibrations generated by the moving parts of the device. More importantly, the use of separate needle holders moving in opposite directions permits the execution of a leno structure on both woven layers of a double weave with each passage of a weft yarn, as opposed to only once every two passages of the weft yarn as would be the case if the needles were to move in the same direction. As will be obvious to one skilled in the art, the present embodiment advantageously increases the quality of the lenos of two simultaneously produced woven layers, advantageously increase the resistance of said woven layers to fraying.

[0036] In an embodiment, the second needle holder is being moved by a third pinion. This provides a much better control over the motion of each needle holder. In particular, such an embodiment comprising a third pinion permits moving opposing needles either in the same or opposite directions without having to make further changes to the device. This minimizes setup times when changing production between different products.

[0037] In an embodiment, each pinion is moved by means of a servomotor. Such type of motors are highly controllable while providing a high output in a small package. This further improves the compactness of the device, and makes it advantageously easy to add more devices to a loom. By preference, in a case where multiple lenos are desired in close proximity, multiple second needle holders may be actuated by the same servomotor. Preferably the servomotor is placed below the holders. This makes the device small, allowing it to be installed in the middle of a loom instead of only at the edges.

[0038] In an embodiment, the combined thickness of the set of slot holders, the needle holder and at least two interposed plates of low friction material is 20mm or less. By preference, the combined thickness is 19mm or less, by more preference 18mm or less. In this way, the device

is advantageously compact.

[0039] In a second aspect, the invention relates to a method for producing fabric having at least one leno construction.

[0040] In a preferred embodiment, the method is being carried out on a loom equipped with at least one device comprising:

- at least one needle holder movable in a vertical direction, with a vertical needle, for the guidance of a first warp thread, and
- a set of two slot holders movable in a vertical direction for the guidance of a second crossing warp thread, wherein a first slot holder comprises a first oblique slot.

[0041] Each holder is fitted on a track secured to a main frame of the loom, a second slot holder comprises a second oblique slot. The first oblique slot and the second oblique slot overlap. The first slot holder and the second slot holder are movable relative to each other between a first extreme position and a second extreme position. In an intermediate position between the first extreme position and the second extreme position the first oblique slot and the second oblique slot form a cross. In the first extreme position a first end of the first oblique slot and a first end of the second oblique slot overlap. In the second extreme position a second end of the first oblique slot, opposite to the first end of the first oblique slot, overlaps with a second end of the second oblique slot, opposite to the first end of the first oblique slot. The needle holder is movable between a third extreme position and a fourth extreme position. In the third extreme position the needle blocks a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder. In the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder.

[0042] The method comprises the steps of:

- passing a plurality of warp threads through said device, the first warp thread passing through a needle and the second warp thread through corresponding oblique slots on the at least two slot holders,
- moving the needle holder to the fourth extreme position,
- moving the slot holders to the first or second extreme position, causing the second warp thread passing through the slot of each of said slot holders to shift laterally,
- passing at least one weft thread transversally relative to said warp threads, said weft passing between the warp threads carried by the at least one needle and the warp threads carried by the slot holders,
- moving the needle holder to the third extreme position,

- passing at least one weft thread transversally relative to said warp threads,
- returning to said first step of moving the needle holder to the fourth extreme position.

[0043] The slot holders alternately move between the first extreme position and the second extreme position.

[0044] The method is advantageous because it ensures reliable lateral displacement of at least one warp yarn. The method also allows to have a leno construction in the middle of the fabric.

[0045] In an embodiment, the method comprises the additional step of moving the needle holder to the third extreme position in between the subsequent steps of moving the slot holders to the first extreme position or the second extreme position and passing at least one weft thread transversally relative to said warp threads, and the additional steps of moving the needle holder to the fourth extreme position or the second extreme position in between the subsequent steps of passing at least one weft thread transversally relative to said warp threads and moving the needle holder to the third extreme position, wherein the slot holders alternately move between the first extreme position and the second extreme position.

[0046] In this way, the method permits to create a leno construction at every weft insert. This method is especially beneficial in combination with a previously described embodiment of the device with two needles moving in opposite directions, because it enables the creation of a leno construction at every weft insert for a double weave.

[0047] In an embodiment, the fabric is a double weave, wherein a leno is constructed in at least each layer of the fabric.

[0048] However, it is obvious that the invention is not limited to this application. The method according to the invention can be applied in all sorts of woven products using any type of filaments or combinations thereof. This advantageously permits combining multiple advantageous properties inherent to multiple types of yarn and/or filament in a synergistic way.

DESCRIPTION OF FIGURES

[0049] With as a goal illustrating better the properties of the invention the following presents, as an example and limiting in no way other potential applications, a description of a number of preferred applications of the device for the production of fabric of leno construction based on the invention.

[0050] FIG. 1 schematically presents a device (1) according to the invention configured to produce a two yarn leno. The device (1) shown comprises one vertical needle (2) providing for the guidance of a first warp thread (3). The figure further shows a set of two slot holders (3, 5) movable in a vertical direction for the guidance of a second crossing warp thread (6), wherein the first slot

holder (4) comprises a first oblique slot (7) and the second slot holder (5) comprises a second oblique slot (8). The first oblique slot (7) and the second oblique slot (8) overlap and are movable relative to each other between a first extreme position shown in Fig. 1a and a second extreme position shown in Fig. 1b. In an intermediate position (not shown) between the first extreme position and the second extreme position the first oblique slot (7) and the second oblique slot (8) form a cross. In the first extreme position a first end of the first oblique slot (7) and a first end of the second oblique slot (8) are shown overlapping. In the second extreme position a second end of the first oblique slot (7), opposite to the first end of the first oblique slot (7), overlaps with a second end of the second oblique slot (8), opposite to the first end of the first oblique slot (7).

[0051] FIG. 2 show a side view of the device (1) of Fig. 1. The figure shows both slot holders (4, 5) and a needle (2) having a plate of low friction material (9) between each of the holders (4, 5) and the needle (2). A second warp yarn (6) is shown passing through the slots (7, 8) of the slot holders (4, 5) and next to the needle (2), which needle (2) carries the first warp yarn (3). Both warp yarns (3, 6) are shown intersecting before a weft yarn (10) traversing in a direction substantially perpendicular to both of said warp yarns (2, 6).

[0052] FIG. 3 schematically presents a device (1) according to the invention configured to produce a three yarn leno. The figure shows that each slot holder (4, 5) comprises two oblique slots (7, 7', 8, 8') placed at different heights. The first ends of both oblique slots (7, 7', 8, 8') being vertically aligned with each other, and the second ends of both oblique slots (7, 7', 8, 8') being vertically aligned with each other. Fig. 3a and Fig. 3b each show both extreme positions of the slot holders (4, 5).

[0053] FIG. 4 schematically presents a device (1) according to the invention configured to simultaneously produce two lenos on each of two layers of a double weave woven material. Each slot holder (4, 5) is shown comprising a first set of vertically aligned oblique slots (7, 7', 8, 8') and a second set of vertically aligned oblique slots (7'', 7''', 8'', 8'''), said second set being vertically aligned with said first set, each set comprising two or four oblique slots (7, 7', 7'', 7''', 8, 8', 8'', 8'''), a first needle holder (not shown) and a second needle holder (not shown), each needle holder comprising at least one needle (2, 2'), said needle (2) of the first needle holder being vertically aligned and directed opposite to the needle (2') of the second needle holder, each pair of opposed needles (2, 2') being aligned with each vertically aligned first and second set of oblique slots (7, 7', 7'', 7''', 8, 8', 8'', 8'''). Fig 4a and Fig. 4b show both extreme positions of the slot holders (4, 5).

[0054] It is supposed that the present invention is not restricted to any form of realization described previously and that some modifications can be added to the presented example of fabrication without reappraisal of the appended claims. For example, the present invention has been described referring to yarn, but it is clear that

the invention can be applied to any types of filaments for instance or to different combinations of fibers.

List of numbered items:

[0055]

- 1 device
- 2 needle
- 3 first warp thread
- 4 first slot holder
- 5 second slot holder
- 6 second warp thread
- 7 first oblique slot
- 8 second oblique slot
- 9 low friction material
- 10 weft yarn

Claims

1. Device for producing fabric with leno construction, the device comprising:

- at least one needle holder movable in a vertical direction, with a vertical needle, for the guidance of a first warp thread; and
- a set of two slot holders movable in a vertical direction for the guidance of a second crossing warp thread, wherein a first slot holder comprises a first oblique slot;

characterized in, that a second slot holder comprises a second oblique slot, wherein the first oblique slot and the second oblique slot overlap, wherein the first slot holder and the second slot holder are movable relative to each other between a first extreme position and a second extreme position, wherein in an intermediate position between the first extreme position and the second extreme position the first oblique slot and the second oblique slot form a cross, wherein in the first extreme position a first end of the first oblique slot and a first end of the second oblique slot overlap, wherein in the second extreme position a second end of the first oblique slot, opposite to the first end of the first oblique slot, overlaps with a second end of the second oblique slot, opposite to the first end of the first oblique slot, wherein the needle holder is movable between a third extreme position and a fourth extreme position, wherein in the third extreme position the needle blocks a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder and wherein in the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder.

2. The device according to claim 1, **characterized in, that** each slot holder is fitted on a track secured to a main frame of a loom, each holder being moved by means of a rack and pinion mechanism, the rack of a first slot holder of each set of two slot holders being moved by a first pinion, the rack of the at least one needle holder and the rack of the of each second slot holder of each set of two slot holders are moved by the same pinion such that said needle holder is 180 degrees out of phase relative to said second slot holder.

3. The device according to claim 2, **characterized in, that** the higher position of the first slot holder is at least 5mm higher relative to the position of the second slot holder, and the lower position of the first slot holder is at least 5mm lower relative to the position of the second slot holder.

4. The device according to any of the previous claims, **characterized in, that** each pair of holders is interposed by a plate of a low friction material, said plate comprising a slot configured to permit the passage of yarn while each of the slot holders is at or between a first extreme position and a second extreme position.

5. The device according to claim 4, **characterized in, that** the combined thickness of the set of slot holders, the needle holder and at least two interposed plates of low friction material is 20mm or less.

6. The device according to any of the previous claims, **characterized in, that** each slot holder comprises two oblique slots placed at different heights, wherein the first ends of both oblique slots of a slot holder are vertically aligned with each other, wherein the second ends of both oblique slots of a slot holder are vertically aligned with each other, wherein in the third extreme position the needle blocks a passage for the second crossing warp thread between the first and second ends of the oblique slots at different heights of each slot holder and wherein in the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the oblique slots at different heights of each slot holder.

7. The device according to any of the previous claims, **characterized in, that** each slot holder comprises at least two oblique slots disposed side-by-side at the same height, the oblique slots of a slot holder being substantially parallel to each other, and the needle holder comprising a needle for each of the at least two oblique slots, each needle being vertically positioned at an intermediate position between the first end and the second end of its corresponding oblique slot, wherein in the third extreme position each needle blocks a passage for the second crossing warp

thread between the first and second ends of the corresponding oblique slots of the first slot holder and the second slot holder and wherein in the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the corresponding oblique slots of the first slot holder and the second slot holder.

8. The device according to any of the previous claims, **characterized in, that** the needle holder comprises a longitudinal slot configured to permit the passage of yarn while each of the slot holders is at or between a first extreme position and a second extreme position.

9. The device according to any of the previous claims 1-8, **characterized in, that** each slot holder comprises a first set of oblique slots and a second set of oblique slots, said second set being vertically aligned with said first set, each set comprising one or two oblique slots, the needle holder further comprising at least two vertically aligned needles directed opposite to each other and being aligned with each vertically aligned first and second set of oblique slots, wherein in the third extreme position a first needle blocks a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and a second needle clears a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder, and wherein in the fourth extreme position the first needle clears a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and the second needle blocks a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder.

10. The device according to any of the previous claims 1-8, **characterized in, that** each slot holder comprises a first set of oblique slots and a second set of oblique slots, said second set being vertically aligned with said first set, each set comprising one or two oblique slots, the device further comprising a first needle holder and a second needle holder, each needle holder comprising at least one needle, said needle of the first needle holder being vertically aligned and directed opposite to the needle of the second needle holder, each pair of opposed needles being aligned with each vertically aligned first and second set of oblique slots, wherein the first needle holder and the second needle holder are movable between a third extreme position and a fourth extreme position, wherein in the third extreme position

said needle of the first needle holder blocks a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and said needle of the second needle holder blocks a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder, and wherein in the fourth extreme position said needle of the first needle holder clears a passage for the second crossing warp thread between the first and second ends of the first set of oblique slots of the first slot holder and the second slot holder and said needle of the second needle holder clears a passage for the second crossing warp thread between the first and second ends of the second set of oblique slots of the first slot holder and the second slot holder.

11. The device according to previous claim 9, **characterized in, that** the second needle holder being moved by a third pinion.

12. The device according to any of the previous claims, **characterized in, that** each pinion is moved by means of a servomotor.

13. Method for producing fabric having at least one leno construction, the method being carried out on a loom equipped with at least one device comprising:

- at least one needle holder movable in a vertical direction, with a vertical needle, for the guidance of a first warp thread; and
- a set of two slot holders movable in a vertical direction for the guidance of a second crossing warp thread, wherein a first slot holder comprises a first oblique slot; wherein each holder is fitted on a track secured to a main frame of the loom, a second slot holder comprises a second oblique slot, wherein the first oblique slot and the second oblique slot overlap, wherein the first slot holder and the second slot holder are movable relative to each other between a first extreme position and a second extreme position, wherein in an intermediate position between the first extreme position and the second extreme position the first oblique slot and the second oblique slot form a cross, wherein in the first extreme position a first end of the first oblique slot and a first end of the second oblique slot overlap, and wherein in the second extreme position a second end of the first oblique slot, opposite to the first end of the first oblique slot, overlaps with a second end of the second oblique slot, opposite to the first end of the first oblique slot, wherein the needle holder is movable between a third extreme position

tion and a fourth extreme position, wherein in the third extreme position the needle blocks a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder and wherein in the fourth extreme position the needle clears a passage for the second crossing warp thread between the first and second ends of the oblique slots of the first slot holder and the second slot holder, the method comprising the steps of:

- passing a plurality of warp threads through said device, the first warp thread passing through a needle and the second warp thread through corresponding oblique slots on the at least two slot holders;
- moving the needle holder to the fourth extreme position;
- moving the slot holders to the first or second extreme position, causing the second warp thread passing through the slot of each of said slot holders to shift laterally;
- passing at least one weft thread transversally relative to said warp threads, said weft passing between the warp threads carried by the at least one needle and the warp threads carried by the slot holders;
- moving the needle holder to the third extreme position;
- passing at least one weft thread transversally relative to said warp threads;
- returning to said first step of moving the needle holder to the fourth extreme position;

wherein the slot holders alternately move between the first extreme position and the second extreme position.

characterized in, that the fabric is a double weave, wherein a leno is constructed in at least each layer of the fabric.

14. The method according to claim 13, **characterized in, that** the method comprises the additional step of moving the needle holder to the third extreme position in between the subsequent steps of moving the slot holders to the first extreme position or the second extreme position and passing at least one weft thread transversally relative to said warp threads, and the additional steps of moving the needle holder to the fourth extreme position and the slot holders to the first extreme position or the second extreme position in between the subsequent steps of passing at least one weft thread transversally relative to said warp threads and moving the needle holder to the third extreme position, wherein the slot holders alternately move between the first extreme position and the second extreme position.

15. The method according to any previous claim 13-14,

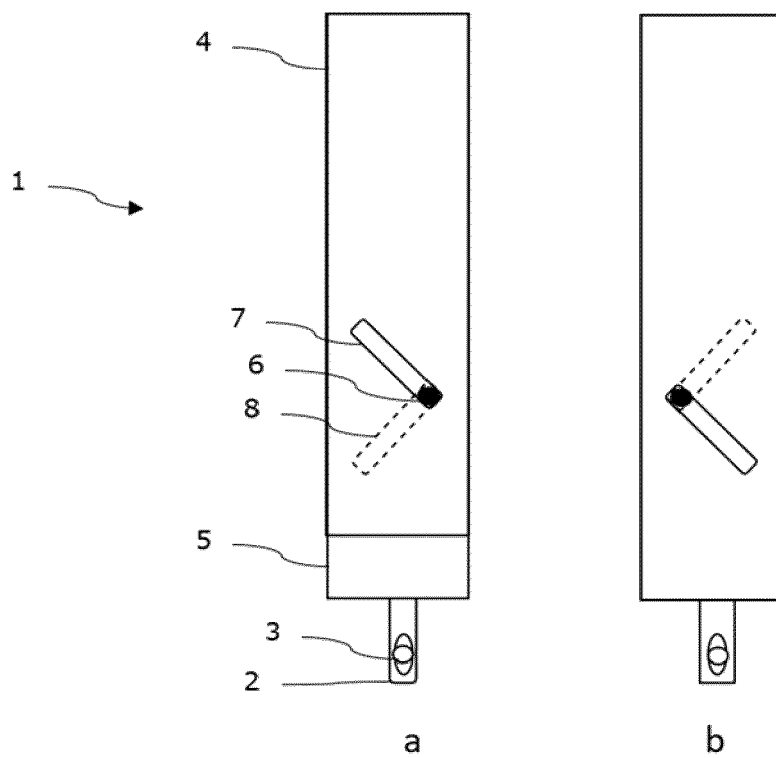


FIG. 1

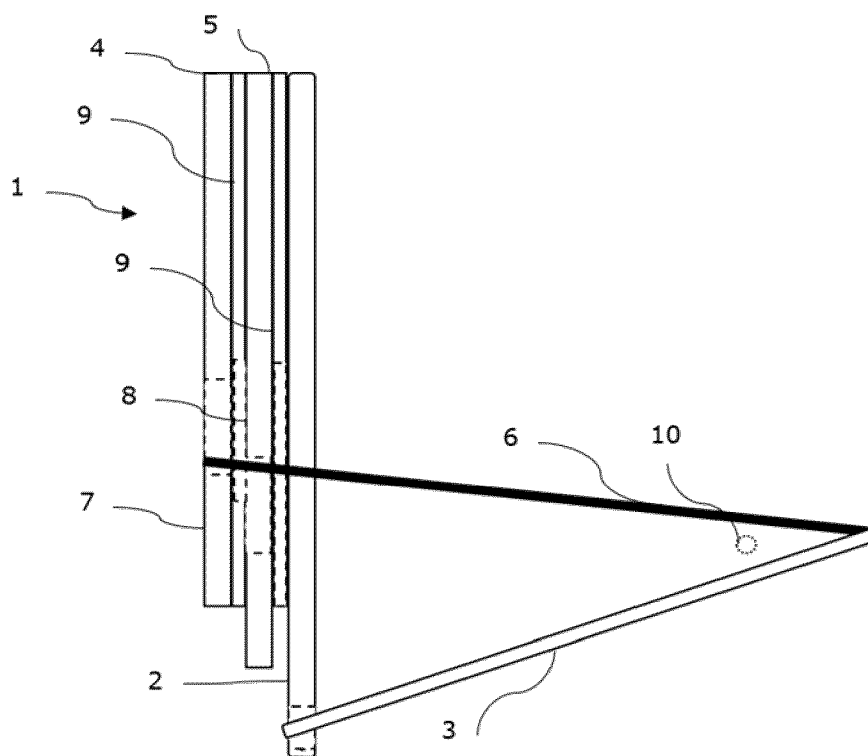


FIG. 2

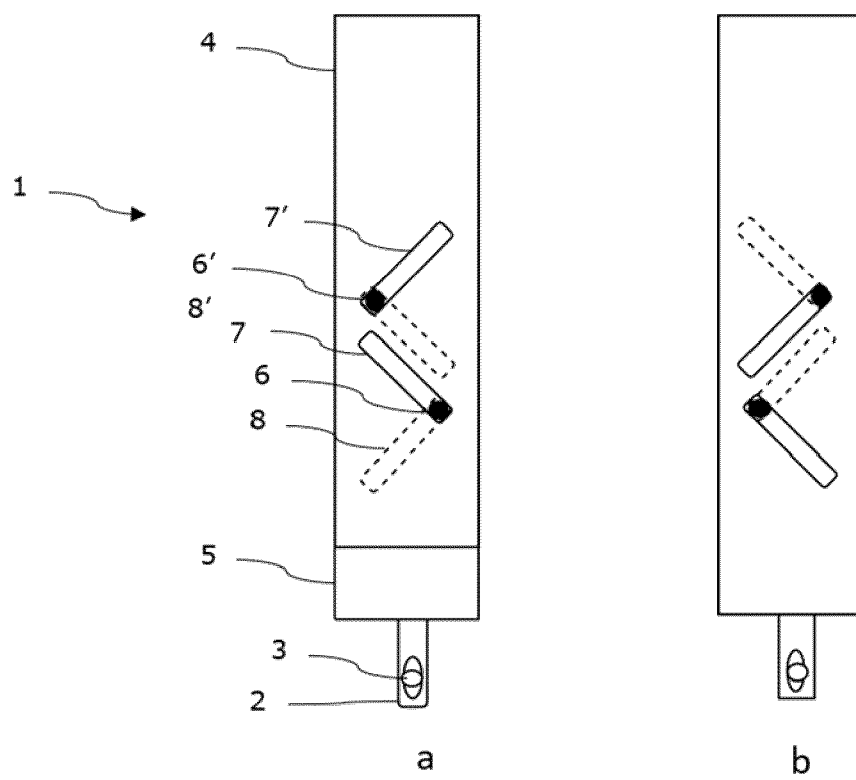


FIG. 3

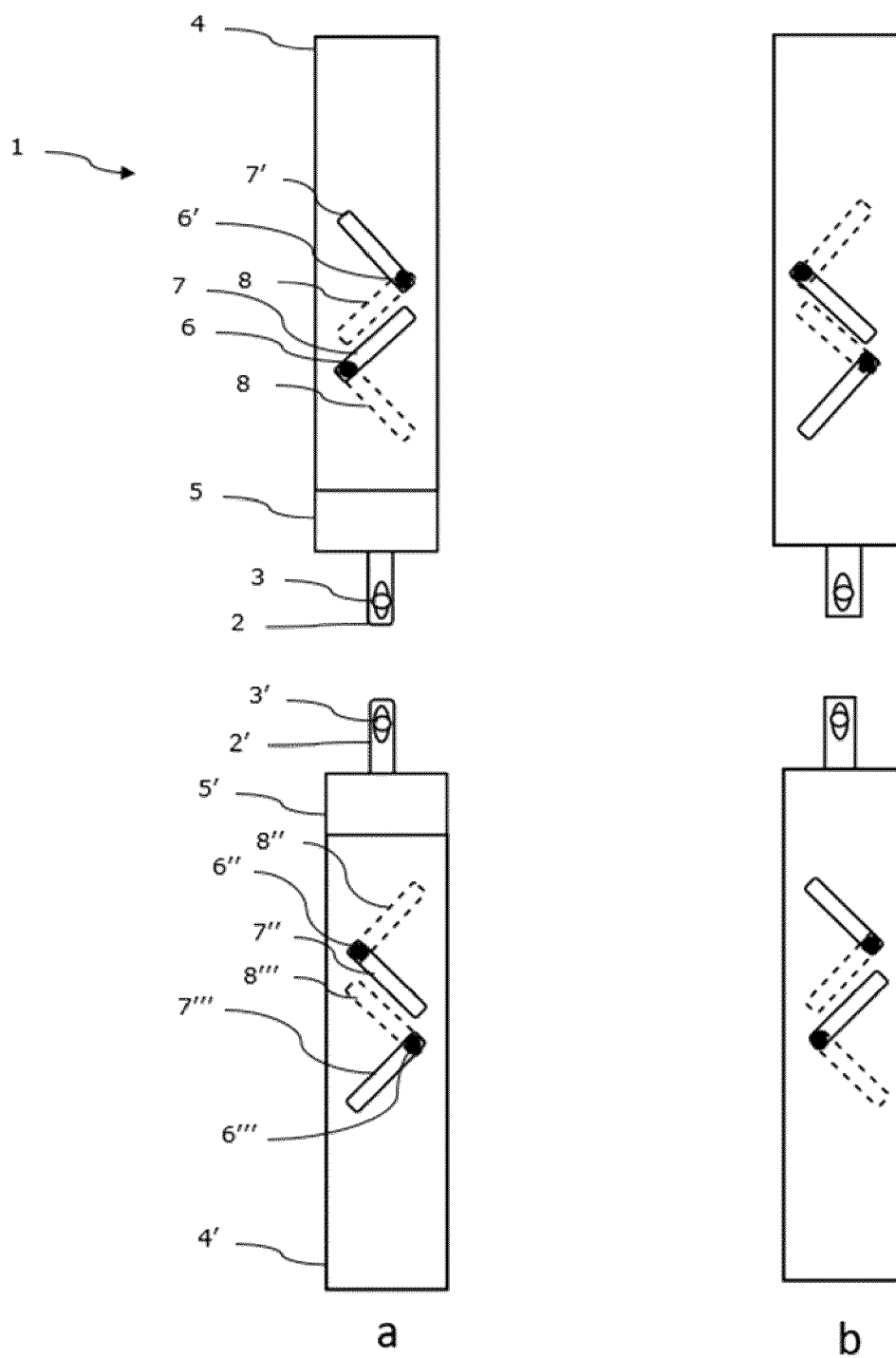


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 23 22 0176

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Place of search Munich		Date of completion of the search 7 May 2024	Examiner Heinzelmann, Eric
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07 - 05 - 2024

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