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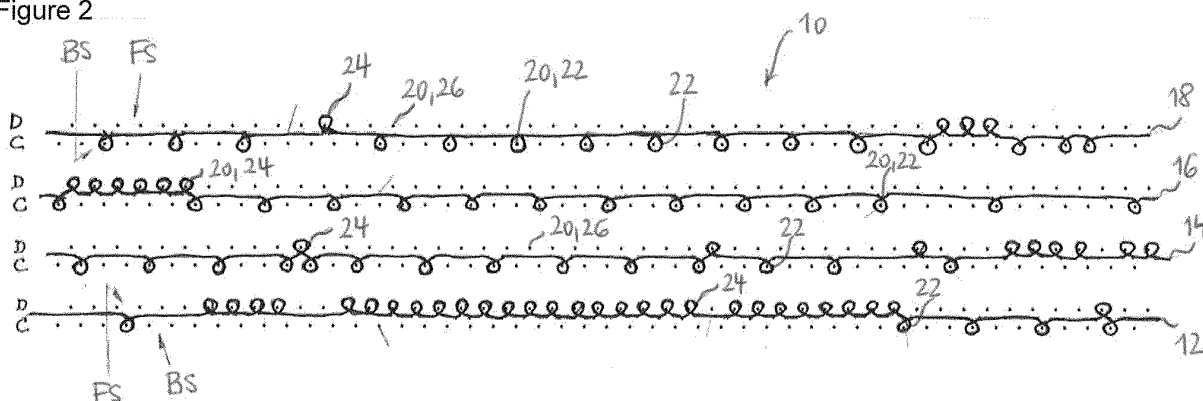
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(54) **METHOD FOR PRODUCING A DOUBLE KNIT FABRIC ON A CIRCULAR DOUBLE JERSEY KNITTING MACHINE**

(57) The present invention relates to a method for knitting a double knit fabric on a double jersey circular knitting machine (CM), the double knit fabric (10) having a front surface (FS) and a back surface (BS), and the circular knitting machine (CM) comprising a cylinder (C) with cylinder needles (CN) and a dial (D) with dial needles

(DN), wherein knitting the front surface (FS) of the double knit fabric (10) with the dial needles (DN) and knitting the back surface (BS) of the double knit fabric (10) with the cylinder needles (CN), such that the back surface (BS) of the double knit fabric (10) provides an outer shield for the front surface (FS) of the double knit fabric (10).

Figure 2



Description

[0001] The present invention relates to a method for producing a double knit fabric on a circular double jersey knitting machine, the use of a circular double jersey knitting machine for producing a double knit fabric, and a circular double jersey knitting machine.

[0002] In particular, the present invention relates to a method for knitting a double knit fabric on a double jersey circular knitting machine, the double knit fabric having a front surface and a back surface, wherein the circular knitting machine comprises a cylinder with cylinder needles and a dial with dial needles.

[0003] Double jersey is the generic name given to a range of weft knitted fabrics made on a rib or interlock basis. Circular knitted double jersey fabric, often referred to as just double jersey or double knit fabric, is a weft knitted fabric constructed with two sets of needles on a circular knitting machine.

[0004] Circular knitting machines have knitting needles arranged in circular configuration which produces tubular fabrics. Circular knitting machines can have a single needle bed in the form of a cylinder. Such circular knitting machines are capable of knitting single jersey fabrics. Circular knitting machines can also have a cylinder with a dial bed mounted directly above the cylinder. Such circular knitting machines are capable of knitting double knit fabrics.

[0005] In a double jersey circular knitting machine, both the cylinder and the dial are provided with needles. Cylinder needles are normally vertically arranged and dial needles are normally horizontally arranged. The needle channels (cut grooves) in the cylinder and dial house the needles. Different dimensions of needle channels can house needles of different thickness in order to produce different fabrics.

[0006] The range of double jersey circular knitting machines can run from simple mechanically controlled machines through to sophisticated electronically controlled jacquard machines. In a single jacquard machine, only the needles of the cylinder can be individually selected electronically, whereas in a double jacquard machine, individual cylinder needle selection and dial needle selection is possible independently from one another.

[0007] Double jersey knitting machines come in a wide range of gauges and diameters, ranging from under 10 inch up to 60 inches or more, for a wide range of applications. The gauge of the knitting machine decides the compactness and fineness of the fabric, and is defined as the needles per inch of the machine. The number of needles used in a circular knitting machine depends on the diameter and the gauge of the machine. The machine gauge may range between E10 and E50, but other values are also possible.

[0008] On circular knitting machines, the tubular fabric may be produced in double-faced or single-faced structures. Irrespective of whether the fabric is double-faced or single-faced, the fabric has two surfaces, a front sur-

face and a back surface. Generally, knitted fabric can be irreversible with an "aesthetic" or visually relevant front surface and a "technical" back surface or can be reversible with the front and back surfaces of the fabric having essentially identical appearance or texture. The "aesthetic" front surface of the fabric is that surface of the fabric that is intended to be seen during normal use of the final product made of the fabric.

[0009] In a circular knitting machine, the tubular fabric usually goes down inside the cylinder towards the centre of the circular knitting machine, is drawn into a fabric take-down device, optionally cut open along its length, and finally collected on a roll winding mechanism. A fabric spreader may gradually convert the tubular fabric into a double layer of folded fabric, wherein the formation of pleats or creases is prevented. Alternatively, the tubular fabric may be cut open along its length, unfolded and wound up into a wide spread single layer of unfolded fabric. Still alternatively, the fabric can be collected in a folding box.

[0010] In known double jersey circular knitting machines, when knitting an irreversible double knit fabric, the cylinder needles are used for knitting the "aesthetic" front surface of the tubular double knit fabric and the dial needles are used for knitting the "technical" back surface of the tubular double knit fabric. As the tubular double knit fabric is drawn downwards during knitting on the double jersey circular knitting machine, the fabric front surface shows on the outside of the fabric tube and the fabric back surface shows on the inside of the fabric tube.

[0011] Since the "aesthetic" front surface of the tubular double knit fabric shows on the outside of the fabric tube, it is a common problem that the front surface gets soiled or impaired during manufacture and/or subsequent steps, such as during packaging or transportation of the wound up fabric.

[0012] A double jersey circular knitting machine is known, for example, from EP 0 591 987 A1. A method for producing a double knit fabric on a circular double jersey knitting machine is known, for example, from EP 0 737 767 A1 and EP 1 975 294 A1.

[0013] It is an object of the present invention to provide a method for producing a double knit fabric on a double jersey circular knitting machine which eliminates or at least greatly reduces the risk of the front surface of the double knit fabric getting soiled or otherwise impaired during or after production. It is another object of the present invention to provide a method for producing a double knit fabric on a double jersey circular knitting machine which allows detection of faults in the double knit fabric that may occur during the knitting process sooner than in known prior art methods.

[0014] The present invention solves this object by providing a method for knitting a double knit fabric on a double jersey circular knitting machine, the double knit fabric having a front surface and a back surface, and the circular knitting machine comprising a cylinder with cylinder needles and a dial with dial needles, wherein the method

comprises knitting the front surface of the double knit fabric with the dial needles and knitting the back surface of the double knit fabric with the cylinder needles, such that the back surface of the double knit fabric provides an outer shield for the front surface of the double knit fabric.

[0015] According to the invention, the "aesthetic" front surface of the tubular double knit fabric shows on the inside of the fabric tube, and the "technical" back surface of the tubular double knit fabric shows on the outside of the fabric tube. Thus, the present invention proposes to reverse the front and back surfaces of the double knit fabric during production such that the back surface rather than the more valuable front surface of the double knit fabric is exposed to dirt, grease, jagged surfaces and the like. Since the fabric back surface protects the integrity of the fabric front surface, less packaging material may be required when transporting the wound-up double knit fabric.

[0016] Preferably, the double jersey circular knitting machine is a double jacquard circular knitting machine, where the cylinder needles and the dial needles can be individually selected electronically. The double jersey circular knitting machine may also be a single jacquard circular knitting machine, where only the cylinder needles can be individually-controlled in an electronic way.

[0017] According to a preferred embodiment, the double knit fabric is an irreversible single-faced structure with a technical back surface and a visually relevant front surface.

[0018] The double knit fabric produced by the method of the present invention may be used for manufacturing a mattress ticking.

[0019] According to another preferred embodiment, at least one inlaid yarn is introduced into the fabric structure by supplying the inlaid yarn across the backs of the needles in order to trap the inlaid yarn inside the double knit fabric.

[0020] In known double jersey circular knitting machines, where the front surface of the tubular double knit fabric is located on the outside of the fabric tube, fault detection in the double knit fabric can be done by an operator observing the tubular double knit fabric as it is being produced. In the present invention, however, this advantage has been exchanged for the benefits achieved by having the front surface of the tubular double knit fabric protected by the back surface of the tubular double knit fabric.

[0021] According to another aspect of the invention, the double jersey circular knitting machine may comprise a fault detection system having an image recording unit and an image processing unit. The method may comprise recording at least one image of the front surface of the double knit fabric with the image recording unit, transmitting the at least one image to the image processing unit, and processing the at least one image with the image processing unit to detect any faults in the double knit fabric.

[0022] The present disclosure further relates to a double jersey circular knitting machine comprising a cylinder with cylinder needles and a dial with dial needles, wherein the dial needles are adapted to knit the front surface of the double knit fabric and the cylinder needles are adapted to knit the back surface of the double knit fabric. The double jersey circular knitting machine may further comprise a fault detection system having an image recording unit, such as a camera, and an image processing unit, such as a computer screen. The image recording unit may be adapted to record at least one image of the front surface of the double knit fabric during a knitting process and transmit the at least one image to the image processing unit. The image processing unit may be adapted to process the at least one image with the image processing unit so as to detect any faults in the produced double knit fabric.

[0023] The image recording unit may be adapted to continuously record the front surface of the double knit fabric during the knitting process. Alternatively, the image recording unit may be adapted to record single images of the front surface of the double knit fabric at different times during the knitting process. The image recording unit may be placed inside the cylinder of the circular double jersey knitting machine. Preferably, the image recording unit is positioned as close to the knitting zone as possible. In this way, a fault in the fabric can be detected sooner than in prior art circular knitting machines, where the visually relevant front surface is at the outside of the fabric tube and only visible to an operator once it has descended down into a lower portion of the machine where the fabric take-away mechanism, including the fabric take-down device and roll winding mechanism, is located. Thus, in prior art machines, if a fault occurs in a particular course, this course must move downwards (as more courses are being knitted) and into view of an operator (or an image recording unit) before the fault within the course can be detected. In the present invention, such a faulty course need not first arrive at a certain location close to the fabric take-away mechanism to become visible for an operator, but can be discovered substantially as soon as the image recording unit has taken an image of the fault in the course. In such a case, the knitting operation may be halted or terminated and less material may go to waste.

[0024] Preferably, the image recording unit comprises a light shielding device for shielding off ambient light. The image recording unit may also comprise an illumination device for illuminating at least a portion of the front surface of the tubular double knit fabric. In this way, an adequate illumination within the tubular double knit fabric can be ensured which can improve image quality and thus fault detection accuracy.

[0025] The image processing unit may simply be a display device for displaying the recorded image data, made up of the recorded images, of the image recording unit. An operator may observe the displayed image data in order to detect any faults visible on the front surface of

the double knit fabric. This step may be performed during or after the knitting process. To this end, the image recording unit may be connected to a data storage unit for storing the image data recorded by the image recording unit and/or processed by the image processing unit. This allows playing back the recorded image data at a reduced speed relative to the knitting speed of the double jersey circular knitting machine, which is usually too high for an operator to recognize any fault in the double knit fabric with the naked eye when observing the double knit fabric as it is being produced.

[0026] The image processing unit may also operate automatically by means of a suitable computer program. For instance, the image processing unit may compare the received image data with theoretical image data which are expected to be achieved by the knitting process if no faults occur. The theoretical image data may be obtained by a design software which is fed into a control unit of the double jersey circular knitting machine so as to produce the desired tubular double knit fabric.

[0027] The foregoing and other objects, features, and advantages of the invention will become more apparent from the following detailed description using the accompanying figures. In the drawings:

- Fig. 1 shows an exemplary circular knitting machine of the prior art,
- Fig. 2 shows an exemplary yarn path of a textile produced in accordance with the present invention,
- Fig. 3 shows a cut open tube of double knit fabric wound up into a double layer of folded double knit fabric, with the technical back surface of the fabric facing outwards and the visually relevant front surface of the fabric facing inwards;
- Fig. 4 shows a portion of a cylinder and dial of a circular knitting machine as seen from the outside of the machine, wherein the uppermost courses of the double knit fabric are visible, the double knit fabric having its visually relevant front surface facing inwards, hidden from view, and the technical back surface facing outwards; and
- Fig. 5 shows an intermediate portion of a circular knitting machine, exposing an image recording unit for monitoring the double knit fabric as it is being produced.

[0028] In the figures, identical or similar parts are provided with the same reference numerals.

[0029] Fig. 1 shows an exemplary circular knitting machine CM of the prior art. The machine CM comprises a free standing circular frame CF providing the support for the majority of the mechanisms of the machine CM. The machine CM comprises as its main sections a yarn supply YS, a knitting system KS, and a fabric take-away mech-

anism FM, which are provided at the upper, intermediate and lower portions of the machine CM, respectively. The knitting system KS comprises the dial D with the dial needles DN (Fig. 4) and the cylinder C with the cylinder needles CN (Fig. 4) which define a knitting zone KZ. The machine CM produces a tube of double knit fabric denoted with FT.

[0030] Fig. 2 shows a symbolic representation of a knitting repeat sequence and its resultant double knit fabric structure 10 in accordance with the present invention, with the commonly employed running thread notation being used. The double knit fabric 10 is irreversible and has an aesthetic front surface FS and technical back surface BS. The front surface FS is visually relevant to a user of the double knit fabric, while the back surface BS is visually irrelevant or at least less visually relevant than the front surface FS.

[0031] In Fig. 3, a fabric tube FT is shown that has been cut open along its length and wound up into a double layer of folded double knit fabric. Fig. 3 reveals the visually relevant front surface FS of the double knit fabric which faces toward the inside of the cut open fabric tube FT, and the technical back surface BS of the double knit fabric which faces outside, such as toward operating personnel OP.

[0032] With reference back to Fig. 2, the continuous lines represent yarns 12, 14, 16, 18 that are being knitted on a circular knitting machine CM. Each point 20 represents a needle and, after the yarn path has been drawn, it may also represent a stitch knitted by that needle. Each horizontal row of points thus represents adjacent needles during the same knitting cycle and the course produced by them. The points just above and below a yarn represent the dial needles DN and the cylinder needles CN, respectively. A circle downwards 22 is a stitch with a cylinder needle CN and a circle upwards 24 is a stitch with a dial needle DN. It is also possible to knit tucks (not shown) instead of stitches 22, 24. A point with no stitch or tuck indicates a float stitch 26, meaning that the associated yarn 12, 14, 16, 18 is being missed by the respective needle.

[0033] Fig. 4 shows a portion of a cylinder C with its cylinder needles CN and dial D with its dial needles DN of a circular knitting machine CM as seen from the outside of the machine CM. The uppermost courses of the double knit fabric 10 are visible. The produced double knit fabric has its visually relevant front surface FS facing inwards, hidden from view, and the technical back surface BS facing outwards.

[0034] Fig. 5 shows an intermediate portion of a circular knitting machine CM according to the present invention. The machine CM is equipped with a fault detection system 100. An image recording unit 102, schematically illustrated as a camera, is arranged so as to face the inner surface (the visually relevant front surface FS) of the fabric tube FT. The image recording unit 102 is used to take images, continuously or non-continuously, of the fabric tube FT as it is being produced. The images can

then be analyzed either by operating personnel OP or by means of a computer program in order to detect faults in the double knit fabric. The distance between the image recording unit 102 and the front surface FS is substantially less than the radius of fabric tube FT as it passes through the intermediate portion of the circular knitting machine CM. For example, the image recording unit 102 may be positioned 3 cm to 20 cm in front of the fabric tube FT. Positioning the image recording unit 102 (or imaging means thereof) in close proximity to the front surface FS allows for better fault detection relative to an image recording unit 102 further away from the fabric tube FT. The image recording unit 102 may further be equipped with a light shielding device 110, such as a funnel attached to the image recording unit 102 so as to shield off ambient light that could negatively affect image quality. The skilled person understands that instead of a funnel, other light shielding devices may be used.

[0035] In the illustrated embodiment, the image recording unit 102 is mounted to a support frame 104. The support frame 104 comprises a first rod 106 extending along a longitudinal axis L of the circular knitting machine CM and a second rod 108 extending substantially orthogonally from the first rod 106. The support frame 104 may be stationary when the tubular fabric FT rotates within the circular knitting machine CM as it is being produced. Thus, the image recording unit 102 automatically scans the courses of the front surface FS of the tubular fabric FT as the tubular fabric FT rotates around the longitudinal center of the machine CM and consequently around the image recording unit 102.

[0036] The skilled person will understand that other support frames may be used to position the image recording unit 102 within the fabric tube FT.

[0037] The image recording unit 102 may be arranged between the knitting zone KZ and the fabric take-away mechanism FM. More specifically, the image recording unit 102 may be placed inside the cylinder C, i.e. within a throughhole defined by an inner surface of the cylinder C. In the illustrated embodiment, the image recording unit 102 is mounted at a position in a transition region between the intermediate and lower portions of the circular knitting machine CM. However, the image recording unit 102 may also be placed closer to the knitting zone KZ. For example, the image recording unit 102 may be arranged up to 50 cm or 100 cm below the knitting zone KZ. Preferably, the camera is arranged between 3 cm and 30 cm below the knitting zone KZ. The image recording unit 102 may not be visible to operating personnel standing outside the circular knitting machine CM.

[0038] The image recording unit 102 may be connected to an image processing unit 112. The connection 114 between the image recording unit 102 and the image processing unit 112 may be wired or wireless. The image processing unit 112 may also be integrated into the image recording unit 102. Additionally or alternatively, the image recording unit 102 may be equipped with or connected to a data storage unit 116, which may also communicate

with the image processing unit 112. The image processing unit 112 may be a display device, such as a screen.

List of references

[0039]

CM	circular knitting machine
CF	frame
YS	yarn supply
KS	knitting system
KZ	knitting zone
FM	fabric take-away mechanism
FT	fabric tube
FS	front surface
BS	back surface
C	cylinder
CN	cylinder needles
D	dial
DN	dial needles
OP	operating personnel
10	double knit fabric
12, 14, 16, 18	yarns
20	point
22, 24	stitch
26	float stitch
100	fault detection system
102	image recording unit
104	support frame
106	first rod
108	second rod
110	light shielding device
112	image processing unit
114	connection
116	data storage unit

Claims

1. A method for knitting a double knit fabric (10) on a double jersey circular knitting machine (CM), the double knit fabric (10) having a front surface (FS) and a back surface (BS), and the circular knitting machine (CM) comprising a cylinder (C) with cylinder needles (CN) and a dial (D) with dial needles (DN), **characterized by** knitting the front surface (FS) of the double knit fabric (10) with the dial needles (DN) and knitting the back surface (BS) of the double knit fabric (10) with the cylinder needles (CN), such that the back surface (BS) of the double knit fabric (10) provides an outer shield for the front surface (FS) of the double knit fabric (10).
2. The method of claim 1, wherein the cylinder needles (CN) and/or the dial needles (DN) are individually selected electronically.
3. The method of claim 1 or 2, wherein the double knit

fabric (10) is used for a mattress ticking.

4. The method of any one of claims 1 to 3, wherein at least one inlaid yarn is inserted into the double knit fabric (10).

5. The method of any one of claims 1 to 4, wherein the double knit fabric (10) is an irreversible single-faced structure with a technical back surface (BS) and a visually relevant front surface (FS).

6. The method of any one of claims 1 to 5, wherein the double jersey circular knitting machine (CM) comprises a fault detection system (100) having an image recording unit (102) and an image processing unit (112), the method comprising:

recording at least one image of the front surface (FS) of the double knit fabric (10) with the image recording unit (102),

transmitting the at least one image to the image processing unit (112), and

processing the at least one image with the image processing unit (112) so as to detect faults in the double knit fabric (10).

7. Use of a double jersey circular knitting machine (CM) for performing the method of any one of claims 1 to 6.

8. A double jersey circular knitting machine (CM) adapted to perform the method of any one of claims 1 to 6, comprising:

a cylinder (C) with cylinder needles (CN) and a dial (D) with dial needles (DN), the cylinder (C) and the dial (D) forming a knitting zone (KZ) of the double jersey circular knitting machine (CM), wherein the dial needles (DN) are adapted to knit the front surface (FS) of the double knit fabric (10) and the cylinder needles (CN) are adapted to knit the back surface (BS) of the double knit fabric (10).

9. The double jersey circular knitting machine (CM) of claim 8, further comprising a fault detection system (100) having an image recording unit (102) and an image processing unit (112), wherein the image recording unit (102) is adapted to record at least one image of the front surface (FS) of the double knit fabric (10) during a knitting process and transmit the at least one image to the image processing unit (112), and wherein the image processing unit (112) is adapted to process the at least one image so as to detect faults in the produced double knit fabric (10).

10. The double jersey circular knitting machine (CM) of claim 8 or 9, wherein the image recording unit (102)

comprises a light shielding device (110) for shielding off ambient light.

11. The double jersey circular knitting machine (CM) of any one of claims 8 to 10, wherein the image recording unit (102) comprises an illumination device for illuminating at least a portion of the front surface (FS) of the tubular double knit fabric (10).

12. The double jersey circular knitting machine (CM) of any one of claims 8 to 11, wherein the image recording unit (102) is placed inside the cylinder (C) of the double jersey circular knitting machine (CM).

Figure 1

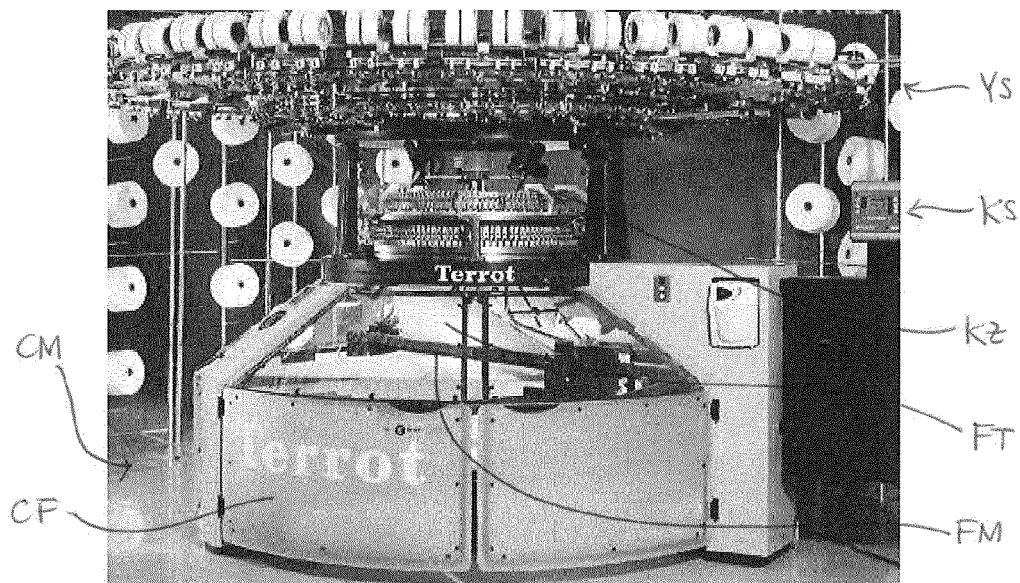


Figure 2

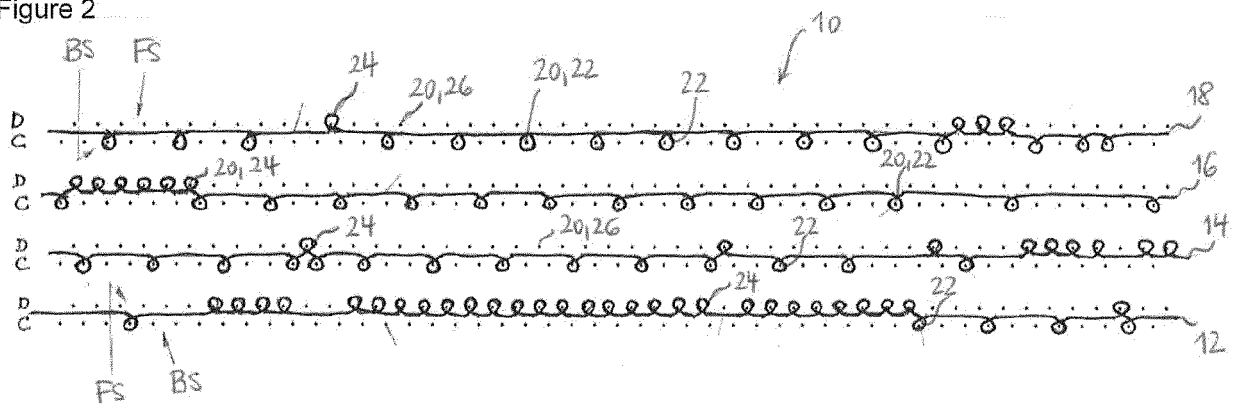


Figure 3

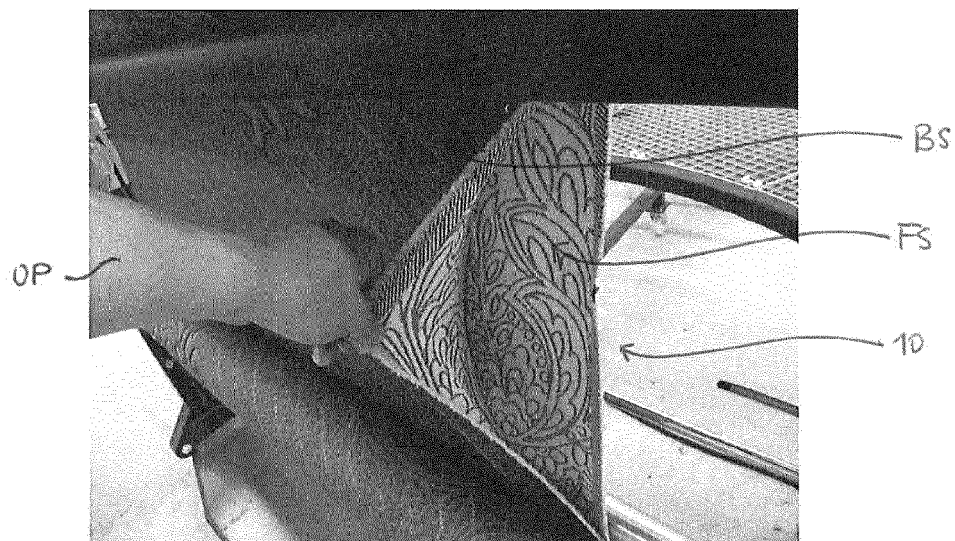


Figure 4

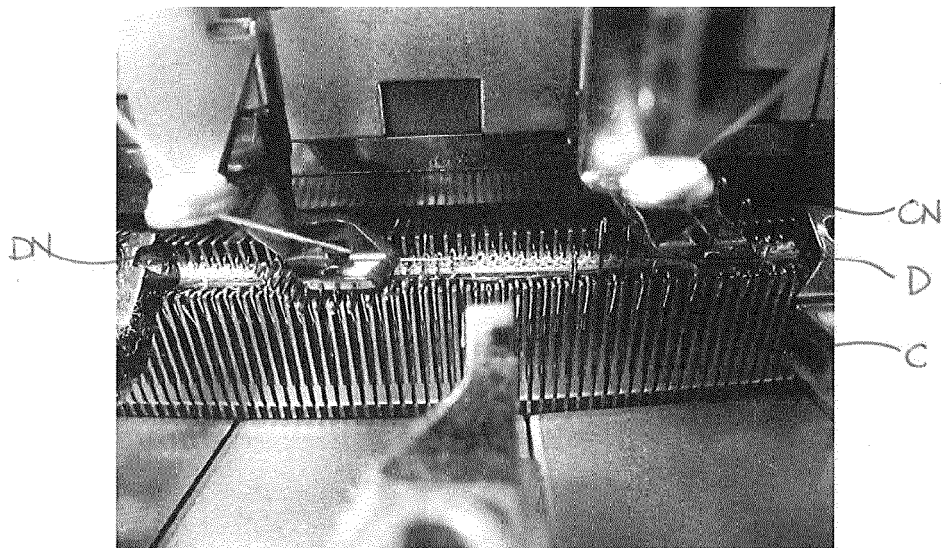
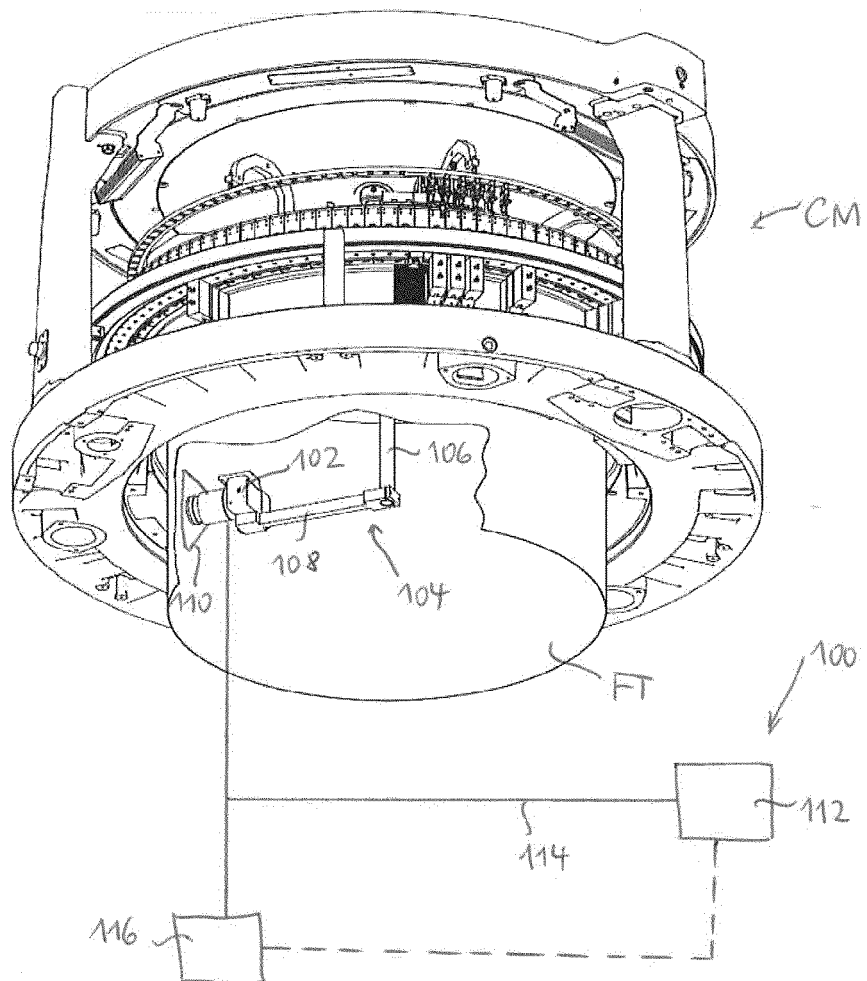


Figure 5





EUROPEAN SEARCH REPORT

 Application Number
 EP 17 18 5970

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			D04B
Place of search		Date of completion of the search	Examiner
Munich		12 January 2018	Braun, Stefanie
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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