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needle bed (2) to pass through the attachment loop (12) while knitting a following knitting-row.

KNITTING MACHINE AND METHOD OF CONTROLLING

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

5 This invention relates to a knitting machine, to a method of controlling a knitting machine, to a computer program controlling a knitting machine and to a product produced with the method.

DESCRIPTION OF PRIOR ART

10 Previously there are known products, such as sweaters or scarfs, for instance, where the opposite sides of the knitwear are produced to have different colors or patterns. Such products are produced by knitting two different layers, each having the desired color or pattern. These layers are then attached on top of each other, such that the back sides of each layer are hidden against each other and the opposite outer sides of the knitwear remain visible with the desired
15 color and pattern.

 A challenge with products of this type is how to implement the attachment of the layers. It has turned out to be challenging to obtain the attachment in such a way that it is not visible from either side of the product.

SUMMARY OF THE INVENTION

20 An object of the present invention is to solve the above-mentioned drawback and to provide a solution which in an invisible and smooth way attaches the layers to each other such that a high-quality product with layers firmly attached to each other in an invisible way is obtained. This object is achieved with a knitting machine according to independent claim 1, a method
25 according to independent claim 5, a computer program according to independent claim 7 and a product according to independent claim 8.

 When the knitting is carried out in such a way that non-knitting needles are provided to a second needle bed, these non-knitting needles can be utilized for engaging and holding engaged the thread used on the second
30 needle bed, while the knitting needles of the first and second needle bed continue produce at least one intermediated row. At that stage the engaged thread can be transferred from the non-knitting needles to corresponding knitting needles on the first needle bed, where the thread can form an attachment loop

through which a thread used on the first needle bed is passed while knitting a following knitting-row. This results in a firm and invisible attachment between the layers of the product.

Preferred embodiments of the invention are disclosed in the
5 dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

In the following the present invention will be described in closer detail by way of example and with reference to the attached drawings, in which:

Figure 1 illustrates a side view of a knitting-machine, and
10 Figure 2 illustrates a method of knitting with the knitting-machine of Figure 1.

DESCRIPTION OF AT LEAST ONE EMBODIMENT

Figure 1 illustrates a simplified side view of a knitting-machine 1.
15 For simplicity, only parts necessary for understanding the invention have been illustrated in Figure 1. The knitting-machine 1 includes a flat first needle bed 2 and a flat second needle bed 3 each having a plurality of needles 4 arranged in a row after each other, due to this only the closest needles 4 are visible in Figure 1.

20 The needles 4 in the first needle bed 2 and second needle bed 3 are roughly oriented in a 90° angle in relation to each other. A thread feeder 5 is illustrated at a position above a gap or space 9 between the needle beds. The product 8, such as a sweater or scarf which is produced by the knitting machine 1, exits the knitting machine downwards via this space 9 between the needle
25 beds. In Figure 1, the product 8 is illustrated to consist of two layers which after knitting are attached to each other, as will be later explained.

In order to operate the needles 4, the knitting machine 1 comprises an actuator system 6 and a control unit 7. The actuator system 6 includes a first part to the right in Figure 1 for operating the needles of the first needle bed 2
30 and a second part to the left in Figure 1 for operating the needles of the second needle bed. The operation is carried out by contact between different parts of the actuator system and the needles 4 in order to control the needles 4 to move in different ways according to the current need to obtain knitting. In order to be able to operate a very large number of needles in a row, the actuator system 6
35 is preferably slidable along the first and second needle beds 2, 3 such that only

needles 4 been currently located at actuators of the actuator system 6 are operated by the actuator system 6 at each moment. Needles located in other parts of the needle beds remain stationary until the actuator system 6 slides to their position for contacting them during knitting.

5 The control unit 7 may be implemented as a computer running a software, or as separated components including a processor and a memory, for instance. In this way the knitting machine 1 may be controlled to operate and perform knitting based on a computer program stored in the memory of the control unit 7, for instance. The computer program may be entered into the
10 memory of the control unit 7 via a keyboard and by using a display provided to the control unit 7. Alternatively, the computer program may be created at a separate computer and transferred via a communication path separate computer to the control unit. Instead of using a communication path for transferring the computer program to the control unit, it is possible to store the
15 computer program from the separate computer on a portable memory, such as a memory card or USB stick, for instance, which is then attached to the control unit 7.

Figure 2 illustrates a method of knitting with the knitting-machine 1 of Figure 1. In Figure 2 the first needle bed 2 and the second needle bed 3 are
20 seen from above, and the product 8 which is produced by knitting with the needles 4 moves downwards in the space 9 between the first and second needle beds. For simplicity, only some of the needles and threads are illustrated.

In Figure 2 it is by way of example assumed that the knitting is carried out by using threads of two different colors only, though in practical
25 implementations it is possible to use a larger number of threads of different colors.

The needles 4 are of similar type as in previously known knitting machines. In the upper left corner of Figure 2 the structure of an outer end of one needle is illustrated by way of example in more detail in an encircled area.
30 The outer end of the needle frame is provided with a hook. A pivotable pin 44 is attached to the needle frame at a joint 45, such that the pin 44 may rotate around the joint 45. In this way, depending on the position of the pin 44, a loop of thread surrounding the needle frame and which is sliding along the needle frame towards the outer end of the needle may either end up in the hook, or slide over
35 the hook along the pin 44 to leave the needle.

On the first needle bed 2 all illustrated needles 4 are used for knitting. Consequently, in the first needle bed 2 all needles 4 are knitting needles 41 knitting with threads 10 having a first color. By way of example, three such threads 10 are illustrated in Figure 2.

5 On the second bed 3, however, also non-knitting needles 42 are provided. Between the non-knitting needles 42 a predetermined number of knitting needles 41 are provided. In the illustrated example this predetermined number is one, which means that every second needle 4 is a non-knitting needle 42. However, in other implementations the predetermined number may be
10 bigger than one. If the predetermined number is two every third needle 4 is a non-knitting needle 42 and if the predetermined number is three every fourth needle 4 is a non-knitting needle 42, and so on. The predetermined number has an impact on how often an attachment loop 12 can be created on a row, in other words on the number of locations where the first layer and second layer of the
15 product 8 are attached to each other. Consequently, the predetermined number can be freely selected to be suitable for the product in question. On the second needle bed 3 the knitting-needles 41 are knitting with a thread 11 having a second color. By way of example, three such threads 11 are illustrated in Figure 3.

20 During knitting, the knitting needles 41 on the second needle bed 3 are used for knitting, row by row. With selected knitting-row intervals at least some of the non-knitting needles 42 on the second needle bed 3 engage a thread 11 currently used on the second needle bed 3 and remain engaged to the thread 11. In the following, it is by way of example, as illustrated in Figure 2,
25 assumed that the knitting row interval is 1, in other words some of the non-knitting needles engage the thread on every row. Naturally, it is not necessary that one of the non-knitting needles engages the thread on every row, but instead there may be one or more rows between, where none of the non-knitting needles engages the thread.

30 In Figure 2 row 33 is being knitted, and one of the non-knitting needles 42 (in the middle) has on this row 33 at location 13 engaged the thread 11 currently used on the second needle bed. This non-knitting needle will remain engaged to this thread while the knitting needles 41 on the second needle bed 3 finalize at least one intermediate row, in other words a following knitted row
35 (after row 33) not yet visible in Figure 2. At that stage, when also one additional intermediate row (after row 33) has been knitted with all the knitting needles 41

on the first needle bed, the non-knitting needle 42 at location 13 will transfer the engaged thread 11 to the corresponding needle on the first needle bed 2. The corresponding needle is in that case the knitting needle 42 located below engaged non-knitting needle 42, at location 13 illustrated on the first needle bed 2.

In Figure 2, at location 14 of the first and second needle bed, transfer of the thread 11 has just taken place and an attachment loop 12 has been formed. It should be observed that for clarity, the attachment loop 12, in Figure 2 illustrates as much longer than it will be in an actual product. At this location 14, the non-knitting needle 42 has previously been engaged to the thread 11 on row 32. When at least one intermediate row, in this example intermediate row 33 has been finalized, and all knitting needles 41 on the first and second bed 2, 3 still remain engaged to loops on this row 33, the non-knitting needle 42 at position 14 has moved to a position where the knitting needle 41 on the first needle bed 2 at position 14 can by moving reach the thread 11, and while moving back, create the attachment loop 12. Simultaneously, also at position 15, an attachment loop 12 has been formed in a similar way.

When the attachment loop 12 has been transferred to the knitting needles 41 on the first needle bed 2, the knitting needles 41 attach the first layer and the second layer of the product to each other by knitting a thread 10 used on the first needle bed 2 to pass through the attachment loop 12 while knitting a following row (not illustrated in Figure 2). Consequently, at locations 14 and 15 the attachment loop 12 of thread 11 which is engaged by the knitting needles 41 will have a loop of thread 10 passed through it, so that the attachment loop 12 attaches the first layer knitted on the first needle bed 2 to the second layer knitted on second needle bed 3 to each other.

When the following row (not illustrated in Figure 2) has been knitted on the first and second needle bed, the non-knitting needle 42 at location 13 will transfer the engaged thread 11 to the corresponding knitting needle on the first needle bed, so that again a new attachment loop will be created, and the first and second layers of the product 8 will be attached also at this location.

It should be noted, that in the illustrated example it has been assumed that the non-knitting needle transfers the thread 11 from the second needle bed 3 to the knitting needle on the first needle bed 2 to form an attachment loop as soon as one intermediate row has been finalized. However, in praxis, more than one intermediate row may be finalized when the transfer to

form the attachment loop 12 is implemented. The number of intermediate rows has an impact on how easy or difficult it will be to visually see the attachment loop 12 of thread 11 while looking at the final product from the side of the first layer which is made of the second thread 10, and possibly of different color. If
5 more than one intermediate row is finalized, the attachment loop will be relatively shorter, as it extends over more than one row in the space between the first and second layer of the product. Therefore, it will be tighter and the angle of the attachment loop 12 engaged by the knitting needle 41 will be smaller, due to which the loop is more difficult to see. However, in practical tests it has been
10 verified that a high-quality product can be obtained already when the transfer of the attachment loop 12 is implemented when one intermediate row has been finalized.

It should also be observed, that though the above example suggests that attachment loops 12 attaching the first and second layers to each
15 other are formed on every row, this is only by way of example. In other implementations the attachment may be carried out only every second or third row, or with even bigger knitting-row intervals. In that case the non-knitting needles engage the thread 11 used on the second needle bed only with these selected knitting-row intervals.

20 In the illustrated solution for attaching the first and second layers of the product 8 to each other, the knitting needles 41 of the first needle bed 2 are knitting right side stitches, and the knitting needles 41 on the second needle bed 3 are knitting wrong side stitches. In that case when the needle of the same point does not need to knit on both layers, instead the layers may remain separated
25 from each other, as the attachment is carried out with the attachment loops 12.

The solution illustrated in Figure 2 may be implemented by using more than two threads of different colors on one of the first and second needle beds 2, 3. The total number of threads with different colors may be three or more. In such an embodiment it is advantageous to let the non-knitting needles
30 42 on the second needle bed 3 remain engaged to the thread 11 while the knitting needles 42 on the first needle bed 2 and on the second needle bed 3 finalize a sufficient number of intermediate rows until a thread 10 with a color matching as closely as possible the color of the engaged thread 11 is used for knitting on the first needle bed 2, at which stage the attachment loop 12 is
35 transferred to the knitting needles 41 on the first needle bed 2. Consequently, the attachment loop 12 is formed when the knitting needle 41 receiving the

thread 11 from the second needle bed is knitting with a thread 10 having approximately the same color as is the color of the thread 11 which is used to form the attachment loop 12.

5 It is to be understood that the above description and the accompanying figures are only intended to illustrate the present invention. It will be obvious to a person skilled in the art that the invention can be varied and modified without departing from the scope of the invention.

CLAIMS:

1. A knitting machine comprising:
 - a first needle bed (2) with a plurality of knitting needles (41) knitting a
5 first layer of a product (8) with right side stitches,
 - a second needle bed (3) with a plurality of knitting needles (41)
knitting a second layer of the product (8) with wrong side stitches, and
 - an actuator system (6) with a control unit (7) actuating needles (4) of
the first needle bed (2) and the second needle bed (3) to move in a
10 predetermined way, **characterized** in that, the control unit (7) is configured to
control the actuator system (6) such that:
 - all needles (4) on the first needle bed (2) are knitting needles (41)
knitting the first layer of the product (8),
 - non-knitting needles (42) are provided on the second needle bed (3)
15 such that between the non-knitting needles (42) a predetermined number of
knitting needles (41) are provided, wherein the predetermined number is at least
one,
 - with selected knitting-row intervals at least some of the non-knitting
needles (42) on the second needle bed (3) engage a thread (11) used on the
20 second needle bed (3) and remain engaged to the thread (11) while the knitting
needles (41) on the first needle bed (2) and on the second needle bed (3) finalize
at least one intermediate row,
 - when the at least one intermediate row has been finalized, the non-
knitting needles (42) engaged to the thread (11) and corresponding knitting
25 needles (41) on the first needle bed (3) move to transfer the engaged thread
(11) forming an attachment loop (12) from the engaged non-knitting needles (42)
to the corresponding knitting needles (41) on the first needle bed (2), and
 - when the attachment loop (12) has been transferred to the knitting
needles (41) on the first needle bed (2), the knitting needles attach the first layer
30 and the second layer of the product to each other by knitting a thread (10) used
on the first needle bed (2) to pass through the attachment loop (12) while knitting
a following knitting-row.
2. The knitting machine according to claim 1, wherein the right side
stitches and the wrong side stitches form a pattern where the needles (4) at the
35 same point do not knit on both levels.

3. The knitting machine according to one of claims 1 to 2, wherein at least one of the first needle bed (2) and the second needle bed (3) is knitting with more than one thread each having a different color.

4. The knitting machine according to one of claims 1 to 3, wherein
5 threads of at least three different colors are used by the first and second needle beds (2, 3), and

the non-knitting needles (42) on the second needle bed (3) remain engaged to the thread (11) while the knitting needles (41) on the first needle bed (2) and on the second needle bed (3) finalize a sufficient number of intermediate
10 rows until a thread with a color matching as closely as possible the color of the engaged thread (11) is used for knitting on the first needle bed (2), at which stage the attachment loop (12) is transferred to the knitting needles (41) on the first needle bed (2).

5. A method of controlling a knitting machine comprising:
15 knitting with right side stitches a first layer of a product with a first needle bed (2) having a plurality of knitting needles (41),

knitting with wrong side stitches a second layer of the product with a second needle bed (3) having a plurality of knitting needles (41), and

attaching the first layer and the second layer to each other to form the
20 product, **characterized** in that, method comprises:

knitting the first layer of the product with all needles (4) on the first needle bed (2), which all are knitting needles (41),

knitting the second layer of the product with only a part of the needles (4) of the second needle bed (3), wherein non-knitting needles (42) are provided
25 such that between the non-knitting needles (42) a predetermined number of knitting needles (41) are provided, wherein the predetermined number is at least one,

engaging a thread (11) with selected knitting-row intervals by at least some of the non-knitting needles (42) on the second needle bed (3),

30 keeping the engaged non-knitting needles (42) engaged to the thread (11) while the knitting needles (41) on the first needle bed (2) and on the second needle bed (3) finalize at least one intermediate row,

transferring the engaged thread (11) forming an attachment loop (12) from the engaged non-knitting needles (42) to the corresponding knitting
35 needles (41) on the first needle bed (2) when the at least one intermediate row has been finalized, and

10

attaching the first layer and the second layer of the product to each other by knitting a thread (10) used on the first needle bed (2) to pass through the attachment loop (12) while knitting a following knitting-row, when the attachment loop (12) has been transferred to the knitting needle (41) on the first
5 needle bed (2).

6. The method according to claim 5, wherein at least one of the first needle bed (2) and the second needle bed (3) is knitting with more than one thread each having a different color.

7. A computer program for controlling a knitting machine to carry out
10 a method according to one of claims 5 to 6.

8. A knitted product produced with a method according to one of claims 5 to 6.

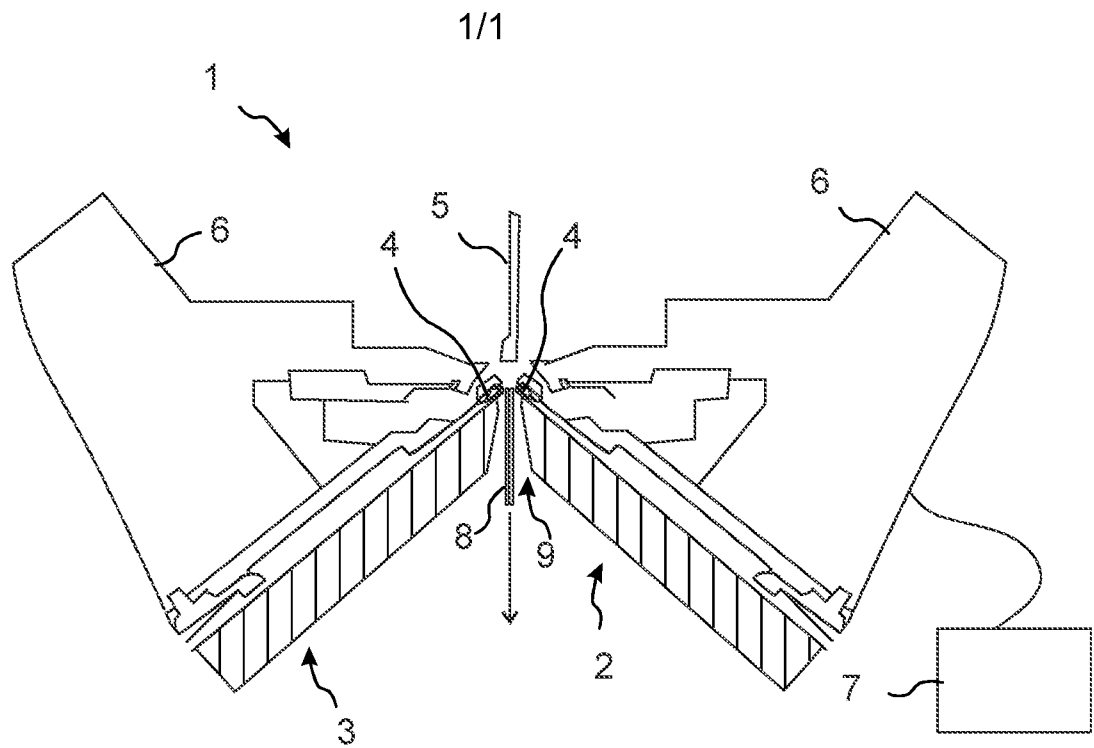


FIG. 1

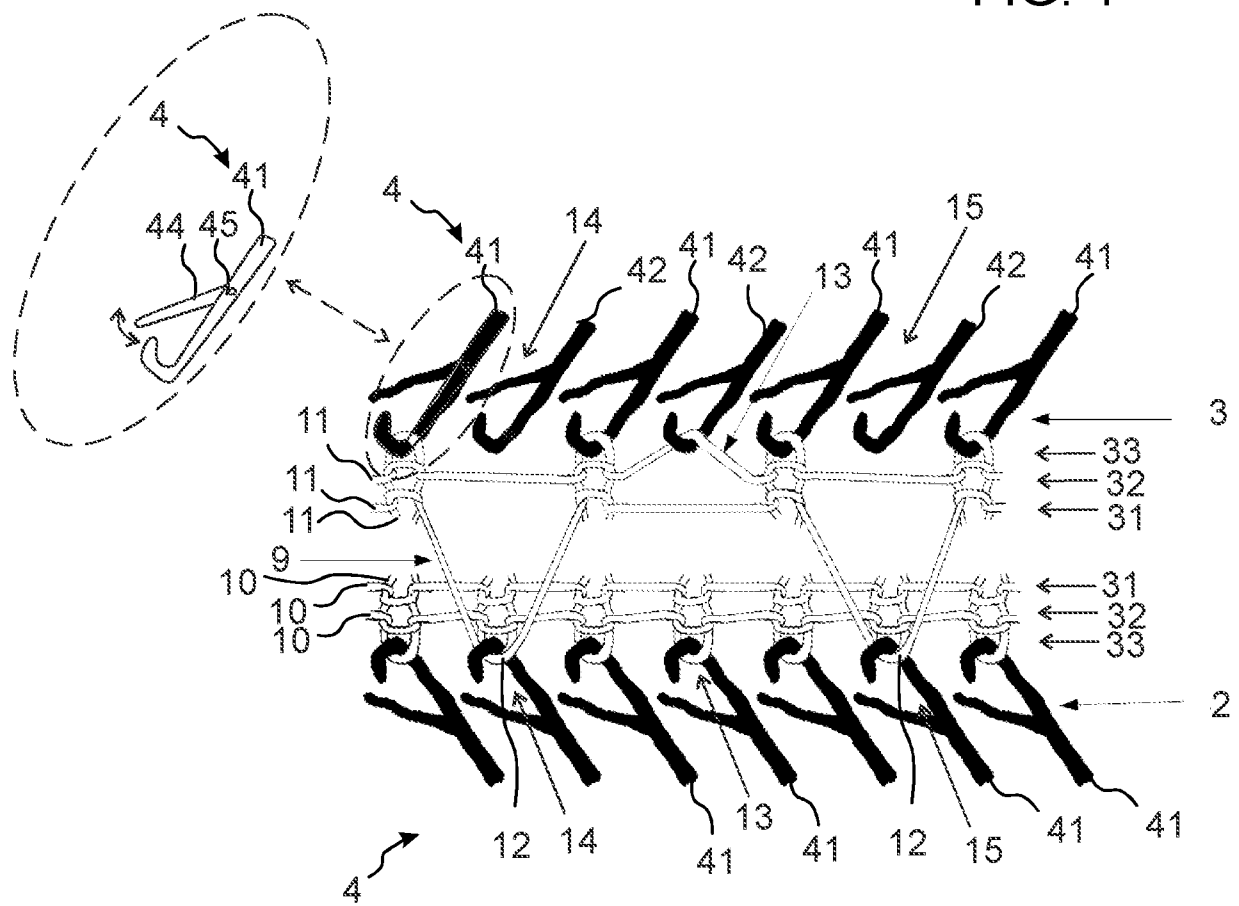


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2024/000011

A. CLASSIFICATION OF SUBJECT MATTER See extra sheet According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: D04B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched FI, SE, NO, DK Electronic database consulted during the international search (name of database and, where practicable, search terms used) EPODOC, EPO-Internal full-text databases, Ansera full-text translation and non-patent literature databases, WPIAP, IPRally		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016108566 A1 (TSENG TSUNG-MIN [TW] et al.) 21 April 2016 (21.04.2016) the whole document, especially paragraphs [0037]–[0054]; figures 1, 2, 5, and 6	1-8
A	US 7770415 B2 (ABRAMO JACQUES [CH]) 10 August 2010 (10.08.2010) the whole document, especially column 4, lines 43–60; claim 1; figure 1	1-8
A	US 2002152776 A1 (DIDIER LAURENT CHRISTIAN [FR]) 24 October 2002 (24.10.2002) the whole document, especially paragraphs [0009] and [0016]–[0022]; figures 1–3	1-8
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
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"D" document cited by the applicant in the international application		
"E" earlier application or patent but published on or after the international filing date		
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"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 08 October 2024 (08.10.2024)	Date of mailing of the international search report 08 October 2024 (08.10.2024)	
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 113604946 A (INNER MONGOLIA KING DEER CASHMERE CO LTD) 05 November 2021 (05.11.2021) figures 3–7 & abstract [online] EPODOC & WPI & machine translation into English by EPO [online] Ansera, page 4, line 1 – page 10, line 2	1-8
A	WO 2022063800 A1 (SMITH & NEPHEW [GB]) 31 March 2022 (31.03.2022) abstract, paragraph [55] and figure 3	1-8

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Information on Patent Family Members

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CLASSIFICATION OF SUBJECT MATTER

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D04B 15/66 (2006.01)