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(54) Method of knitting a double-knit fabric and circular knitting machine for this use.

(57) A method of knitting a thickened double-knit fabric and a circular knitting machine for this use is disclosed. Sinkers **(15)** are supported for inward and outward movement between cylinder needles **(2)** and dial needles **(3)**. Each sinker **(15)** includes a stitch drawing ledge **(15a)** and a neb **(15d)** on the inner end portion of each of the sinkers and cooperates with adjacent needles **(2,3)** in the formation of knit stitch loops. The outer end portions of the sinkers are supported on a rotatable ring **(14)** located exteriorly of the needle cylinder **(1)** for movement of the sinkers **(15)** in a radial direction and along a downwardly inclined path of travel between the needles **(2,3)**. The inner end portions of the sinkers **(15)** are supported for movement along the downwardly inclined path of travel. When the cylinder needles **(2)** and dial needles **(3)** are in a clearing position, yarn is fed thereto. While the cylinder and dial needles **(2,3)** are successively moved downwardly and inwardly, the sinkers **(15)** are simultaneously moved in an outwardly and upwardly direction along the downwardly inclined path of travel. While the cylinder and dial needles **(2,3)** are respectively lowered and retracted, the stitch drawing ledge **(15a)** engages the yarn and cooperates with associated adjacent needles **(2,3)** to form stitch loops of a length determined by the amount of upward vertical movement imparted to the stitch forming ledge **(15a)** of the sinker and the amount of downward and inward movement of the cylinder and dial needles **(2,3)**.

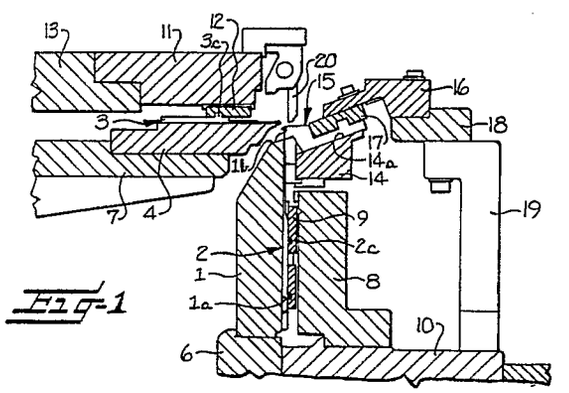

Fig-1

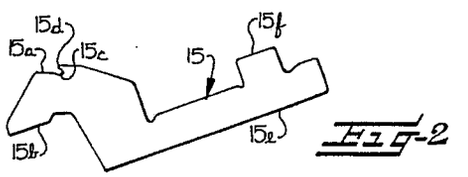

Fig-2

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METHOD OF KNITTING A DOUBLE-KNIT FABRIC AND CIRCULAR KNITTING MACHINE FOR THIS USE

This invention relates generally to a method of knitting a double-knit fabric and a circular knitting machine for carrying out this method wherein the vertical length of travel of the cylinder needles is reduced by lowering the stitch forming ledge of the sinkers as the needles are being raised to clearing level and raising the stitch forming ledge of the sinkers as the needles are being drawn downwardly to stitch drawing level, and more particularly, to such a method and machine wherein the sinkers are supported for inward and outward movement between the dial and cylinder needles along a downwardly inclined path of travel and with the sinkers being moved outwardly and upwardly as the needles are drawn downwardly to raise the level of the stitch drawing ledge during stitch loop formation and with the sinkers being moved inwardly and downwardly as the needles are raised so that the shed stitch loops are moved inwardly and downwardly by the nebs of the sinkers.

During movement of the cylinder and dial needles in a conventional double-knit circular knitting machine, a newly formed loop slides downward on the needle stem and provides the various pattern structures desired. When forming a pattern structured fabric, such as a rib knit structure, any yarn breakage during knitting typically results in the knit fabric dropping from the machine. When dropping occurs, the yarn from the cup end of the dropped fabric must be threaded onto at least every two or three needles and then restored to its initial state before dropping. This mandates an operator's slowly running the knitting machine to assure proper threading.

In Japanese patent publication SHO 63-42186, a double-knit circular knitting machine is disclosed which solves some of the aforementioned problems by the application and use of a novel sinker. However, as disclosed in this Japanese publication, the distance between the foremost end of the sinker and the rotating dial is shortened when the sinker advances to the inner side of the machine. As a result, a thick fabric cannot be knitted unless the dial is upwardly moved for increasing the separation distance so as to allow a knitted fabric to easily pass through the formed gap without interference. Because the sinker is arranged perpendicularly to the knitting needle, the sidewall of the sinker rest ring is small, thus creating an unstable sinker movement.

With the foregoing in mind, it is an object of the present invention to provide a method of knitting a double-knit fabric on a circular knitting machine which overcomes the aforementioned deficiencies of the prior art.

It is still another object of this invention to provide a double-knit circular knitting machine used for practicing the aforementioned method which overcomes the deficiencies of the prior art.

In accordance with the present invention, a double-knit circular knitting machine includes a plurality of cylinder needles supported in a rotating needle cylinder for vertical movement parallel to the axis of rotation of the needle cylinder. Dial needles are radially slidable on a sinker dial and are operative with the cylinder needles. Sinkers are supported for inward and outward movement between the cylinder needles. Each sinker includes a stitch drawing ledge and a neb on the inner end portion of each of the sinkers. The sinkers cooperate with adjacent needles in the formation of knit stitch loops. The outer end portions of the sinkers are supported on a rotatable ring located exteriorly of the needle cylinder for movement in a radial direction and along a downwardly inclined path of travel between the needles. The inner end portions of the sinkers are supported on a sinker nose ring for movement along the downwardly inclined path of travel.

Yarn is fed to the needles when the cylinder needles are in a raised, clearing position and when the dial needles are in an outward advanced position. The cylinder needles are successively moved downwardly while the dial needles are successively moved inwardly. The sinkers are simultaneously moved in an outwardly and upwardly direction along the downwardly inclined path of travel while the cylinder needles are being lowered and the dial needles are being retracted so that the stitch drawing ledge engages the yarn. The stitch drawing ledge cooperates with the associated adjacent needles to form stitch loops of a length determined by the amount of upward vertical movement imparted to the stitch forming ledge and the amount of downward and inward movement of the cylinder and dial needles.

The cylinder needles are successively moved upwardly and the dial needles are successively moved outwardly after forming the stitch loops therewith. The sinkers are simultaneously moved in an inwardly and downwardly direction along the downwardly inclined path of travel to engage sinker nebs with the fabric and move the same inwardly and downwardly to aid in shedding the stitch loops from the cylinder and dial needles as they are respectively raised and advanced with the newly formed stitch loop thereon.

In order that the present invention may be more readily understood, reference will now be made to the accompanying drawings, in which:-

Figure 1 is a vertical sectional view through the needle cylinder of the knitting machine and illustrating the manner in which the sinkers are mounted for radial sliding movement along a downwardly inclined path of travel relative to the needles;

Figure 2 is a side elevational view of one of the special type of sinkers utilized in the present invention;

Figure 3 is a somewhat schematic developed elevational view showing the paths of travel of the needles and associated sinkers at one yarn feeding position;

Figures 4 through 10 are side elevations of the upper portions of the cylinder and dial needles and associated sinkers showing their relationship during the successive steps of forming stitch loops and then shedding the previously formed stitch loops from the dial and cylinder needles, and being taken along their respective section lines 4-4 through 10-10 of Figure 3; and

Figure 11 is a side elevational view of a second embodiment of the special type of sinker used in the present invention.

As shown in Figure 1, a rotating needle cylinder **1** is supported on a driven ring gear **6** and the outside surface of the needle cylinder **1** is provided with the usual needle slots **1a** in which cylinder needles, broadly indicated at **2**, are supported for vertical movement parallel to the axis of rotation of the needle cylinder **1**. As illustrated, hooked latch needles are preferred. Each knitting needle **2** is provided with a hook **2a** and a pivoted latch **2b** (Figure 4), and an operating butt, as indicated at **2c** (Figure 1). Conventional knitting cams, including stitch cam means supported on cam plates **9**, are provided for imparting vertical movement to the knitting needles **2**. The cam plates **9** are supported on the inner surface of the cam holder ring **8** which is fixed on a cam ring plate **10**.

A rotating dial **4** is supported on a needle dial hub **7**. The outer surface of the dial **4** is spaced from and extends over an upper portion **1b** of the rotating needle cylinder and is rotatable therewith. The top surface of the dial **4** is provided with the usual needle slots in which hooked latch dial needles, broadly indicated at **3**, are supported for radial movement in conjunction with cylinder needles **2** during knitting operation. Each dial needle **3** is provided with a needle hook **3a** and latch **3b** - (Figure 4), and an operating butt **3c** (Figure 1). Knitting cams, including stitch cam means supported on sinker cam plate **12**, are provided for imparting radial, horizontal movement to the knitting needles **3**. The dial cam plate **12** is supported on the lower surface of a dial cam holder ring **11** which is fixed to a dial cam ring plate **13**.

The upper surface of the needle cylinder includes the downwardly and inwardly inclined surface **1b** which defines a sinker nose support ring for the nose of the sinkers as will be described herein. A sinker support bed **14** is fixed to the exterior of the upper end of the needle cylinder **1** and is provided with a downwardly and inwardly inclined sinker sliding surface **14a** defined by the lower ends of sinker slots formed in the sinker bed **14** and at the same downwardly inclined angle as the sinker sliding surface **1b** of the sinker nose ring defined on the upper surface of the needle cylinder **1**. The inclined surface **1b** and the sliding surface **14a** collectively define sinker support ring means of inverted truncated conical shape. As illustrated, the sinker sliding surface **14a** is located at a lower level than the sinker sliding surface **1b**.

Special types of sinkers, broadly indicated at **15**, cooperate with the cylinder and dial needles **2,3** to form stitch loops and are supported for movement in a radial direction and along a downwardly and inwardly inclined path of travel between the cylinder needles **2**. Inward and outward radial sliding movement of the sinkers **15**, along the downwardly and inwardly inclined path of travel, is controlled by sinker cams **17** supported in a fixed position on a sinker cap **16**. Sinker cap **16** is in turn supported on a sinker cap ring **18** which is supported in spaced-apart locations on the upper ends of support standards **19** surrounding the needle cylinder **1**. As will be noted, the sinker cams **17** are supported in a downwardly inclined position at the same downwardly inclined angle as the inclined sliding surfaces **1b** and **14a** on the respective inclined cylinder surface and sinker bed **14**. The sinker sliding surfaces **1b** and **14a** are illustrated in Figure 1 as being downwardly and inwardly inclined at an angle of around 20° relative to a line perpendicular to the vertically disposed cylinder needles **2**. While this 20° downwardly inclined angle is preferred, the present invention is not limited to this particular angular inclination, but may be positioned at an angle from 10° to 45°, and preferably within the range of 15° to 30°.

As best shown in Figure 2, the outer portion of the special sinker **15** includes an elongate body portion having an outer lower planar sliding edge **15e** adapted to rest upon and slide along the inclined surface **14a** of the sinker bed **14**. The sinker **15** also includes an inner lower planar sliding edge **15b** adapted to rest on and be slidably supported along the inclined sliding surface **1b** on the upper surface of the cylinder **1**. The inner sliding edge **15b** is disposed at a higher level than the outer sliding edge **15e**, as clearly shown in Figure 2. A stitch drawing ledge **15a** is provided on the upper inner portion of the sinker and a neb **15d** extends over the outer portion of the stitch drawing

ledge **15a** and defines a sinker throat **15c** between the neb **15d** and the outer portion of the stitch drawing ledge **15a**. An upstanding operating butt **15f** is provided on the outer and upper end portion of the elongated body portion of the sinker **15**. The butt **15f** extends upwardly at a right angle from the body portion of the sinker **15** and is adapted to be engaged by the sinker cams **17** to impart the required inward and outward radial movement to the sinkers **15**.

In conventional sinkers, the stitch drawing ledge extends along a line which is parallel with the lower planar sliding edge of the sinker. In contrast to this conventional construction, the present special type sinker is characterized by the stitch drawing ledge **15a** being slanted downwardly toward the operating butt **15f** on the outer end portion of the elongate body portion of sinker **15**. The downwardly inclined or outwardly slanting stitch drawing ledge **15a** of the sinker **15** of the present invention is different from the normal type sinker in which the stitch drawing ledge extends parallel to the lower planar sliding edge of the sinker. The present sinker is also different from the special sinkers of the type disclosed in U.S. patent numbers 3,837,185 and 3,986,371 wherein the stitch drawing ledge slants downwardly or inwardly in the direction of the inner end of the sinker.

In Figure 3, the solid line **50** indicates the path of travel of the top of the hook of the cylinder needles **2** during a knitting cycle while the dash-dot line **52** indicates the path of travel of the stitch drawing ledge **15a** during a knitting cycle. The dotted line **51** indicates the path of travel of the dial needle **3**. The alternate long and double-dashed line **53** indicates the path of travel of the sinker throat **15c**. A yarn feed carrier and finger **20** - (Figures 1 and 8) is positioned to feed a yarn indicated at **54** (Figure 8) to the needles as they are moved to a stitch forming level.

In the method according to the invention, the needles **2,3** are successively raised as they approach the knitting station and are moved outwardly to the clearing level along the solid line **50** in Figure 3 to a position where the previously formed loops surrounding the shanks of the cylinder and dial needles **2,3** are positioned beyond the tip of the latches **2b, 3b**, as shown in Figures 4-6. At the same time, the sinkers **15** are moved and retained in an inwardly and downwardly inclined position along the downwardly inclined path of travel between the needles **2,3** so that the fabric is moved inwardly by the neb **15d** to maintain the previously formed stitch loops below the tip of the latches **2b, 3b** and in tight engagement with the shanks of the needles, as shown in Figure 6. The inward and downward movement of the sinker **15** lowers the position of the stitch drawing ledge **15a** below the normal horizontal path of travel, as indicated by the dash-dot line **52** in Figure 3, so that the cylinder needles **2** do not have to be raised as high to reach clearing level as would be the case if the sinkers **15** were maintained at a higher level.

While the cylinder needles **2** are in a raised latch clearing position, and the dial needles **3** are in a most outwardly advanced position, yarn feed finger **20** feeds the yarn **54** to the hooks of the needles **2, 3**. The cylinder needles 2 are lowered and dial needles **3** are retracted while the sinkers **15** begin to move outwardly and upwardly along the downwardly inclined path of travel, as illustrated in Figure 7. With further downward vertical movement of the cylinder needles **2** and further retraction of the dial needles **3**, as indicated in Figure 8, the previously formed stitch loops close the latches **3a, 3b** and the sinker **15** continues to move outwardly and upwardly so that the yarn in the cylinder needle hook **2a** will be drawn downwardly over the stitch drawing ledge **15a** while the stitch drawing ledge **15a** remains in the highest level, as illustrated in Figure 9.

While the yarn is being drawn down over the stitch drawing ledge **15a**, both the outer and inner portions of the sinkers **15** are being supported. As shown in Figures 4-10, the lower planar sliding edge **15b** on the inner end or nose of the sinker **15** is slidably supported on the downwardly and inwardly inclined surface **1b** of the cylinder **1**. Lower planar sliding edge **15e** on the outer end portion of the sinker **15** is slidably supported **14a** of the sinker bed **14** (Figure 1). Thus, both the inner and outer portions of the sinkers **15** are supported as the needles are drawn down to stitch forming level.

As shown in Figure 10, the cylinder needle **2** begins to rise at the point where the dial needle **3** is retracted to the innermost position. At this time, the sinker moves in the inwardly and downwardly direction so that the previously formed stitch loops shed from the upper end of the needle hook **2a** is engaged by the neb **15d** and moved inwardly to aid in shedding the stitch loop from the needle. The sinker throat **15c** pushes the knit fabric and assists the loop on the dial needle **3** to cast-off the stitch. This inward and downward movement of the sinkers **15** ensures that the needles **2** do not again pass upwardly through the shed stitch loop. The cylinder needle **2** continues to rise and the dial needle **3** begins its advance. This begins the start of the knitting cycle as illustrated in Figure 4.

The inward and downward movement of the sinkers **15** ensures that the needles **2** do not again pass upwardly through the shed stitch loop. The sinkers **15** continue to move the fabric inwardly and downwardly as the needle **2** continues to rise, as shown in Figures 4 and 10, so that the newly formed stitch loop is maintained in engagement

with the outer surface of the needle shank and imparts an opening motion to the latches of the needles. This knitting cycle is repeated at each of the subsequent knitting stations around the needle cylinder to form the knit fabric.

Alternatively, a compound or sliding latch needle with a modified cam also can be used in accordance with the present invention. A jacquard apparatus for patterning which can include a pattern wheel, a pattern drug, or other electronic patterning device also can be included for knitting various artistic patterns.

The shape of the sinker is not limited. For example, Figure 11 illustrates a second embodiment of the special type of sinker used in accordance with the present invention. The sinker grooves in the machine can be modified as needed. The forward end of the sinker **150** includes a stitch drawing ledge **150a** extending horizontally. Inclined surface **150b** is in a plane defined by the inclined surface **150e** so that the entire lower edge of the sinker defined by both surfaces **150b, 150e** are guided by sinker grooves. Sinker **150** includes a throat **150c** and a neb **150d**. A control butt **150f** is included.

The use of sinkers **15** in accordance with the present invention offers several benefits. If a knit fabric drops on account of yarn breakage during knitting, the machine can be threaded in a similar manner as a single-knit circular knitting machine. Additionally, a thick fabric can be knitted. The inwardly and downwardly inclined direction of the sinker provides a gap between the tip of the sinker knitting ledge **15a** and the needles **2,3**. Therefore, a knitted fabric can pass between the gap. Thus, the winding tension is more readily applied to the knit fabric which results in the potential for higher quality and a larger knit fabric thickness.

In the drawings and specification there has been set forth the best mode presently contemplated for the practice of the present invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

Claims

1. A method of knitting a double-knit fabric on a circular knitting machine including a plurality of cylinder needles **(2)** supported in a rotating needle cylinder **(1)** for vertical movement parallel to the axis of rotation of the needle cylinder, a plurality of dial needles **(3)** radially slidable on a sinker dial **(4)** and operative with said cylinder needles **(2),** sinkers **(15)** having inner and outer end portions and being supported for inward and outward movement between said cylinder and dial needles **(2,3),** a stitch drawing ledge **(15a)** and a neb **(15d)** on the inner end portion of each of said sinkers **(15)** and cooperating with adjacent needles in the formation of knit stitch loops, a rotatable ring **(14)** positioned exteriorly of said needle cylinder **(1)** for supporting said outer end portions of said sinkers **(15)** for movement in a radial direction and along a downwardly inclined path of travel between said needles **(2,3),** and a sinker nose support ring **(1b)** on the upper portion of said needle cylinder **(1)** for supporting said inner end portions of said sinkers **(15)** for movement along the downwardly inclined path of travel, said method being characterized by the steps of feeding a yarn **(54)** to said needles **(2)** while said cylinder needles are in a raised, clearing position and said dial needles **(3)** are in an outwardly advanced position, successively moving said cylinder needles **(2)** downwardly while moving said dial needles **(3)** inwardly, simultaneously moving said sinkers **(15)** in an outwardly and upwardly direction along the downwardly inclined path of travel while the cylinder needles **(2)** are being lowered and the dial needles **(3)** are being retracted so that said stitch drawing ledge **(15a)** engages the yarn **(54)** and cooperates with associated adjacent needles to form stitch loops of a length determined by the amount of upward vertical movement imparted to said stitch forming ledge **(15a)** of said sinker **(15)** and the amount of downward and inward movement of said cylinder and dial needles **(2,3),** successively moving said cylinder needles **(2)** upwardly and said dial needles **(3)** outwardly after forming the stitch loops therewith, and while simultaneously moving said sinkers **(15)** in an inwardly and downwardly direction along the downwardly inclined path of travel to engage said sinker nebs **(15d)** with the fabric and move the same inwardly and downwardly to aid in shedding the stitch loops from the cylinder and dial needles **(2,3)** as they are respectively raised and advanced with the newly formed stitch loop thereon.

2. The method of knitting a double-knit fabric as set forth in Claim 1 wherein said sinkers B are obliquely moved so that said stitch drawing ledge crosses said cylinder needles at right angles.

3. A circular knitting machine including a plurality of cylinder needles **(2)** supported in a rotating needle cylinder **(1)** for vertical movement parallel to the axis of rotation of said needle cylinder **(1),** a plurality of dial needles **(3)** radially slidable on a sinker dial **(4)** and operative with said cylinder needles **(2),** knitting cam means **(9 and 12)** for raising said cylinder needles **(2)** to a clearing level and for advancing said dial needles **(3)** outwardly and then lowering said cylinder needles **(2)** and retracting said dial needles **(3)** inwardly, sinkers

(15) having inner and outer end portions and being supported for inward and outward movement between said needles, each of said sinkers including a stitch drawing ledge **(15a)** and a neb **(15d)** on the inner end portion of each of said sinkers **(15)** and cooperating with adjacent needles **(2,3)** in the formation of stitch loops, said machine being characterized by means for supporting said sinkers **(15)** for movement in a radial direction and along a downwardly inclined path of travel between said needles, said sinker support means comprising rotatable ring means **(14)** of inverted truncated conical shape located exteriorly of said needle cylinder **(1)**, radially extending slots **(14a)** formed in said ring means **(14)** for slidably receiving and supporting the outer end portions of said sinkers **(15)** therein, a rotatable sinker nose support ring **(1b)** positioned on the upper end of said needle cylinder **(1)** for slidably receiving and supporting the inner end portions of said sinkers **(15)** therein, and wherein said sinkers are inclined downwardly and inwardly toward said needles.

4. A circular knitting machine as set forth in Claim 3 wherein said rotatable ring means is inclined downwardly and inwardly toward said needles at an angle from 10° to 45°.

5. A circular knitting machine as set forth in Claim 3 wherein said rotatable ring means supporting the outer end portions of said sinkers is positioned at a lower level than said sinker nose support ring supporting the inner end portions of said sinkers.

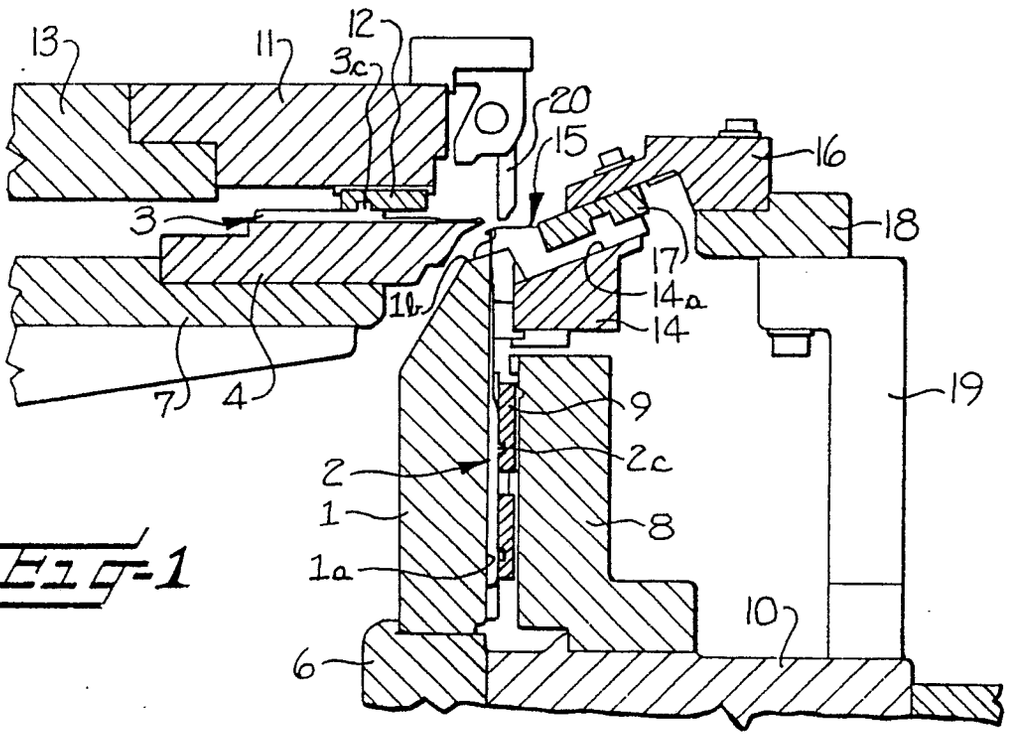

Fig-1

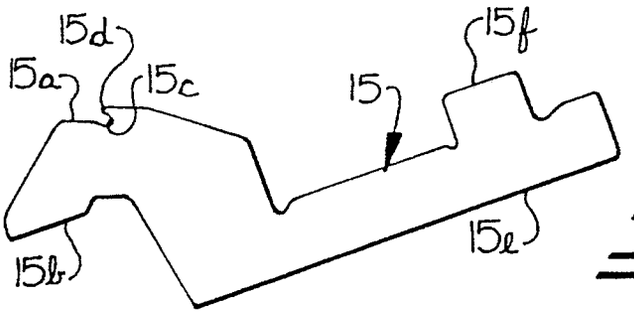

Fig-2

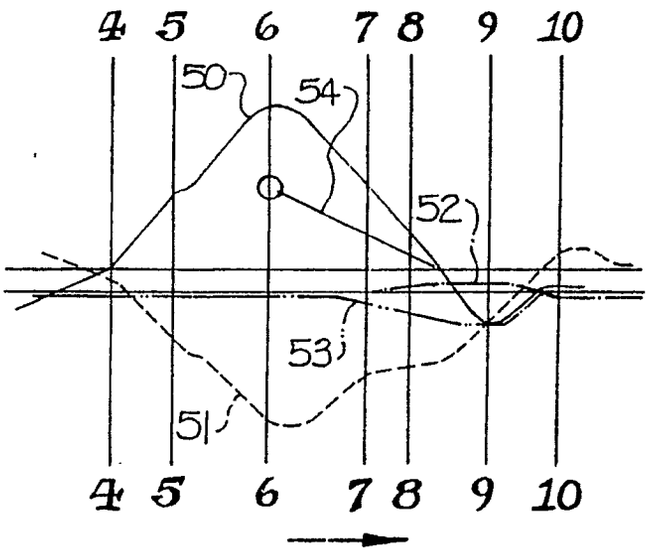

Fig-3

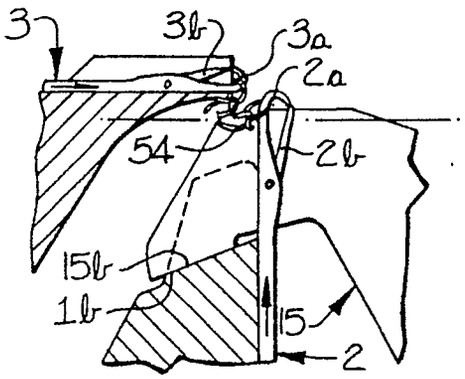

Fig-4

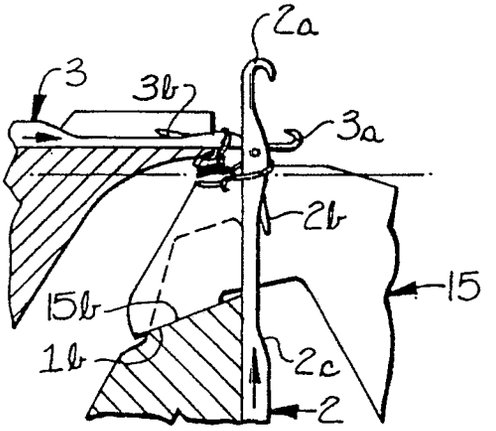

Fig-5

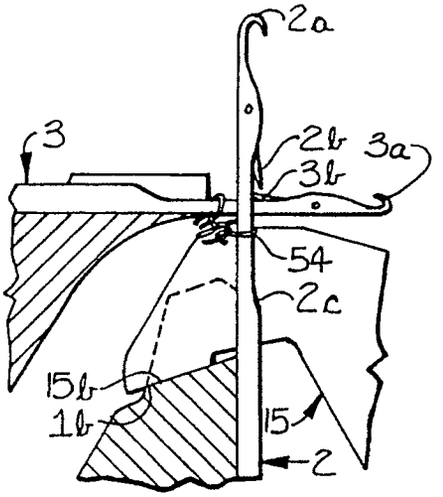

Fig-6

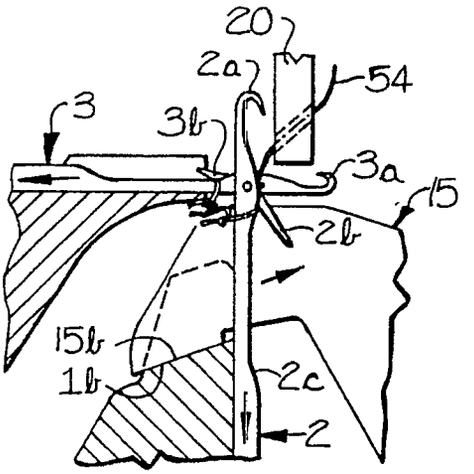

Fig-7

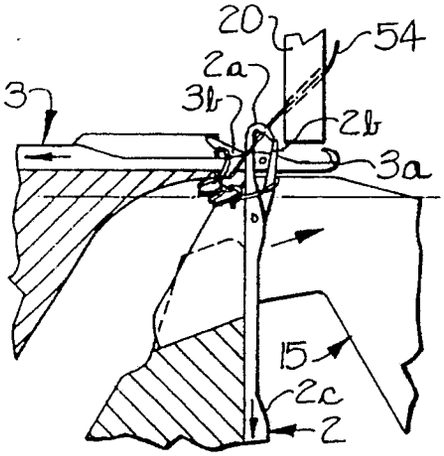

Fig-8

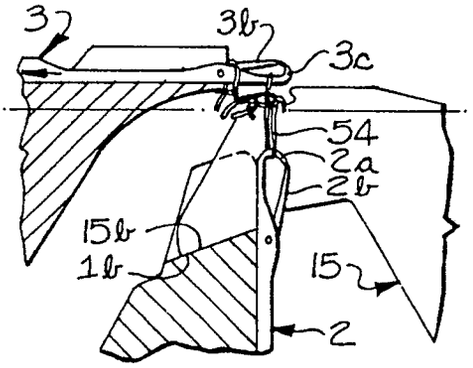

Fig-9

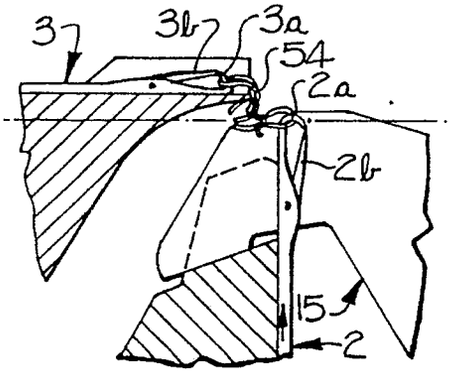

Fig-10

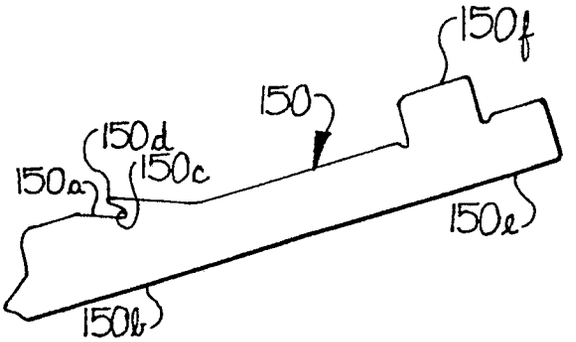

Fig-11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 5898

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-925036 (SCOTT) * page 1, line 50 - page 2, line 10; figures 1-5 *	1, 3	D04B15/06
A	US-A-3986371 (HAVRANEK) * column 3, line 28 - column 6, line 11; figures 1-10 *	1-4	
A,P	EP-A-0351935 (PRECISION FUKUHARA WORKS LTD) * column 5, line 58 - column 9, line 18; figures 1-12 *	1-5	
A	FR-A-671288 (MILLS)		
A	GB-A-1393352 (ELITEX)		
A	DE-A-2756411 (ZINI)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
D04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 SEPTEMBER 1990	VAN GELDER P.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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