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<p>(54) Title: KNITTED FABRIC AND METHOD FOR PRODUCING A KNITTED FABRIC</p>		
<p>(57) Abstract</p>		
<p>A knitted fabric comprising a first knitted fabric portion integrally knitted along a joining line into second and third knitted fabric portions. The first knitted fabric portion is preferably a double-faced weft knitted structure and the second and third knitted portions are each single face weft knitted structures, wherein the first knitted portion may be a rib fabric and the second and third knitted portions may be jersey or plain fabric. The fabric can be produced on a knitting machine having independently controllable first and second sets of knitting needles by knitting a double faced fabric portion utilising needles from both said first and second sets, and knitting onto an edge of said double faced fabric portion a double layer fabric consisting of two single faced fabric portions each knitted on needles from a respective one of the first and second sets.</p>		

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A KNITTED FABRIC AND METHOD FOR PRODUCING A KNITTED FABRIC

5 This invention relates to a knitted fabric and also a method for manufacturing a knitted fabric. The invention also relates to an undergarment which may be formed from such knitted fabric.

10 In the production of certain clothing items from knitted fabric, such as undergarments, it is sometimes necessary or at least desirable to form portions of the garment with more than a single layer of fabric. A mens brief is an example of such an undergarment. In the construction of a mens brief it is advantageous for a front panel thereof to be formed from a double layer of fabric for added support, whilst a back panel is constructed from a single layer fabric to enable easier stretch and fit. In the past the
15 double layer fabric panel has been provided by patterning and cutting an extra panel of fabric and sewing this panel into the front section of the brief during manufacture. However, this process of forming the double fabric layer panel results in seams where the extra panel is sewn onto the fabric of the brief, the seams can prove to be particularly uncomfortable to the wearer of the undergarment. Furthermore, the patterning, cutting
20 and sewing operations required to install the extra panel in the brief increases the cost of manufacture.

 In accordance with the present invention there is provided a knitted fabric comprising a first knitted fabric portion integrally knitted along a joining line into second
25 and third knitted fabric portions.

 The knitted fabric is preferably constructed such that alternate loops or wales of the first portion are knitted to loops or wales of the second and third portions respectively.
30

 Preferably the knitted fabric is formed in a single process on an automated knitting machine.

Further, the first knitted fabric portion is preferably a double-faced weft knitted structure and the second and third knitted portions are each single face weft knitted structures, wherein the first knitted portion may be a rib fabric and the second and third knitted portions may be jersey or plain fabric.

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The second and third knitted portions may also be integrally be knitted along a second joining line into a fourth knitted fabric portion, such that a section of knitted fabric between the joining lines comprises a double layer of fabric constituted by the second and third knitted fabric portions.

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A knitted fabric is also provided comprising a single layer knitted fabric section integrally knitted into a double layer knitted fabric section.

The invention also provides a knitted undergarment of the type adapted to be worn around the groin region of a wearer comprising a double fabric layer gusset portion integrally knitted into the fabric of the undergarment.

The invention further provides a process for producing a knitted fabric on a knitting machine having independent controllable first and second sets of knitting needles, comprising knitting a double faced fabric portion utilising needles from both said first and second sets, and knitting onto an edge of said double faced fabric portion a double layer fabric consisting of two single faced fabric portions each knitted on needles from a respective one of the first and second sets.

The invention further provides a process for producing a knitted fabric on a knitting machine having independently controllable first and second sets of knitting needles, comprising knitting two single faced fabric portions, one on each of the first and second sets of needles, and knitting the two single faced fabric portions together into a double faced fabric portion by utilising both the first and second sets of needles.

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Preferably a plurality of feeder mechanisms are provided in the knitting machine, which, in use, feed thread or yarn to be knitted wherein, during knitting of said two

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single faced fabric portions, thread or yarn from alternate feeder mechanisms are fed to the first and second sets of needles respectively.

The double faced fabric portion may comprise a rib fabric, and the two single
5 faced fabric portions may each comprise a jersey or plain fabric, and may be knitted onto the face loops and the reverse loops respectively of the rib fabric where the double faced and single faced fabrics join.

The present invention also provides a method of controlling a knitting machine
10 having two sets of independently controllable knitting needles, comprising controlling both of the sets of needles so as to knit a double faced fabric and then controlling the two sets of needles so as to knit a single faced fabric on each set of needles, such that each single faced fabric is integrally knitted onto an edge of said double faced fabric, whereby to produce a single layer knitted fabric integrally knitted onto a double layer knitted
15 fabric.

The invention further provides a method of controlling a knitting machine having two sets independently controllable knitting needles, comprising controlling the sets of needles so as to knit a single faced fabric on each set of needles and then controlling both
20 sets of needles so as to integrally knit a double faced fabric onto respective edges of the single faced fabrics, whereby to produce a double layer knitted fabric integrally knitted into a single layer knitted fabric.

In accordance with the invention there is also provided a method of producing a
25 knitted fabric undergarment of the type adapted to be worn around the groin region of a wearer, comprising knitting a length of fabric having an integrally knitted double layer fabric section, and patterning and constructing the undergarment such that a portion of the double layer fabric section is positioned as a gusset portion in the constructed undergarment.

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The invention finally provides a knitted fabric comprising a double layer fabric section integrally knitted between two single layer fabric sections.

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The present invention also provides knitted material comprising a first portion which knits into second and third portions that form two layers, and vice versa.

The invention may be better understood by reference to the following detailed
5 description of preferred embodiments thereof, in which reference is made to the accompanying drawings, wherein:

Figure 1 is a simplified diagram of a circular knitting machine;

Figures 2A and 2B are cutaway schematic views of knitting needles in a knitting machine;

10 Figures 3A, 3B and 3C illustrate the formation of a knitted fabric in accordance with a preferred embodiment;

Figure 4 illustrates a knitted fabric joining portion of a preferred embodiment;

Figure 5 shows a conventional undergarment pattern; and

15 Figure 6 shows patterning of an undergarment fabric in accordance with a preferred embodiment.

In Figure 1 there is shown a circular garment length cylinder and dial type weft knitting machine 2, of a variety which is known in the knitting industry. The basis of weft knitting is to draw a portion of yarn through a previously formed yarn loop so as
20 to form a further loop through which yarn may be drawn. For this purpose the knitting machine 2 is provided with a series of hooked knitting needles 50, best illustrated in Figures 2A and 2B. In a cylinder and dial type knitting machine the knitting needles are arranged in two sets, with the cylinder needles extending vertically and arranged in a circular configuration with hooks facing outwardly, and dial needles arranged radially in
25 a single plane with hooks facing upwards. The hooked portions of the cylinder needles 14 and the dial needles (not illustrated in Figure 1) are disposed adjacent a yarn feeding area where yarn 18 is fed by a yarn feeder 16 to a position whereby to enable the knitting needle hooks to grasp the yarn. In the knitting machine 2 illustrated in Figure 1, the cylinder and dial knitting needles remain rotationally stationary, and the yarn feeders 16
30 rotate so as to feed yarn to the circularly disposed sets of needle hooks. Consequently, a yarn supply 4 comprising sets of yarn reels 6 rotate together with the yarn feeders 16. Also, as can be seen in Figure 2A, a reciprocating linear motion of the knitting needles

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is required to effect the knitting loop formations, and this is brought about by knitting cams 46 and needle butts 48 which act as cam followers. The knitting cams rotate synchronously with the yarn feeders 16, and are indicated generally at 12 in Figure 1.

5 With reference particularly to Figures 2A and 2B, the knitting action of a cylinder and dial knitting machine can be seen. A cutaway portion of the cylinder 42 is shown with a series of needles 60, 62, 64, 66 and 68 disposed in needle slots 70. Each needle is provided with a hook 52 and latch 54 at one end thereof, and a protruding needle butt 48 at the other end. The needle butt 48 is acted upon by knitting cams 46 which rotate
10 in the direction indicated by arrow 44, synchronously with a yarn feeder (not shown in Figure 2) which guides yarn 58 to the position shown for access by the knitting needles. Knitting needle 60 is shown in a rest position where the head of the needle hook is level with the top of the needle slot 70 and a previously formed loop 56 held in the hook 52 closed by latch 54. As the knitting cams 46 rotate past the needles the circular motion
15 of the cams is transformed into a reciprocating linear motion of the needles as can be seen by the relative positions of needles 62, 64, 66 and 68. Knitting needle 62 can be seen where the needle butt passes up the incline of a clearing cam 47, wherein the previously formed loop 56 slides inside the hook 52 and contacts the latch 54, turning and opening it. Needle 64 is shown at the top of the clearing cam 47 where the
20 previously formed loop 56 is cleared from the hook and latch onto the body of the needle. At this point the hook 52 is positioned above the feeding yarn 58, such that when the needle descends down the clearing cam 47 the yarn 58 is grasped by the hook 52, whilst the previously formed loop 56 contacts the underside of the latch 54 causing it to close onto the hook 52. Finally, as the head of the knitting needle descends to the
25 position of needle 68 a newly formed loop 59 is created by drawing yarn 58 downwards whilst the previously formed loop 56 passes over the latch 54. The distance which the needle descends after forming a new loop 59, and before returning to the rest position shown by needle 60 controls the loop length of the knitted fabric. The needles 50 of the cylinder 42 and the needles 50 of the dial 40 are each controlled by separate knitting
30- cams 46. In a knitting machine 2 such as that illustrated in Figure 1 having a plurality of yarn reels 6 and yarn feeders 16 a separate set of cams 46 are provided on each of the cylinder 42 and dial 40 corresponding to each yarn feeder 16. Furthermore, each set of

knitting cams 46 is adjustable (not shown in Figure 2A) to enable the stitches formed as the corresponding yarn feeder passes the needles to be adjusted. In particular, each set of cams 46 may be adjusted so as to vary the length of loop formed (quality), or indeed to vary whether or not a stitch is formed at all when the yarn passes the needles. The positioning of the knitting cams may be controlled during knitting of a garment 29 by means of a control drum 8 (Figure 1). The control drum 8 comprises a rotatable cylinder provided with vertical rows of control studs 28 which act upon control cams 10. The control cams 10 in turn act upon cam followers in the rotating controllable knitting cam portion 12 of the knitting machine 2. Each vertical row on the control drum 8 has a number of holes for providing control studs 28, and it is the vertical position of the hole in the row on the control drum 8 which dictates the function that the knitting machine 2 will perform in response to a control stud 28 placed therein. Rotation of the control drum 8 is in turn controlled in part by a timing chain 24. In particular, an action dictated by a control stud 28 only takes place when the control stud 28 is rotated to a position whereas to cause movement of the corresponding control cam 10. The changes in rotation of the control drum 8 may be dictated by the construction of the timing chain 24. In a cylinder and dial type knitting machine, functions which correspond to respective positions in a control stud row include:

- control of a cylinder clearing cam;
- control of cylinder knitting quality;
- control of a dial clearing cam;
- control of dial knitting quality; and
- control of dwell of the rotational movement of the control drum 8.

In general the control studs 28 in a single row on the control drum 8 relate to the cylinder and dial knitting cams associated with a single yarn feeder 16. For example, a control stud placed in the cylinder clearing cam knit position in a particular row of the control drum 8 causes the cylinder clearing cam 46 corresponding to that row of the control drum to be adjusted to a position so as to cause the cylinder needles to form stitches with the yarn from the corresponding yarn feeder 16. Similarly, a control stud placed in the cylinder clearing cam non-knit position causes the corresponding cylinder clearing cam to be adjusted so as to prevent the cylinder needles from forming knitted stitches with the yarn from the corresponding yarn feeder 16. A control stud placed in

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the dwell position of a particular control drum row prevents further rotational movement of the control drum 8 when that row reaches the rotational position whereby the control studs act upon control cams 10. A control stud placed in the dwell position on the control drum 8 abuts against a dwell lever (not shown) when the corresponding row reaches the control cams 10 so as to prevent the further rotational movement of the control drum 8.

The timing chain 24, sometimes also referred to as the fabric length chain, consists of a series of square ring metal links hooked onto one another so as to form an endless loop which passes over a series of chain sprocket wheels 26. For each link in the timing chain 24 the knitting cams and yarn feeders of the knitting machine 2 make an integral number rotations, whereby an integral number of courses of the knitted fabric 29 is formed for each link in the timing chain 24. Certain links on the timing chain may be provided with a projection which acts upon the dwell lever associated with the control drum 8, whereby when such a link passes the dwell lever, rotational movement of the control drum 8 is enabled. In this way, the number of plain links provided between links having projections in the timing chain 24 dictates the length of knitted fabric produced between knitting changes dictated by the control drum 8.

Two types of knitted fabric which are commonly produced on cylinder and dial type knitting machines are single-faced knitted structures and double-faced knitted structures. A single-faced knitted structure is produced by a single set of knitting needles, e.g. the cylinder needles. Double-faced structures, on the other hand, are produced when two sets independently controlled needles are employed with the hooks of one set knitting or facing in a transverse direction to the other set. The two sets of needles thus draw their loops from their same yarn in opposite directions, so that the fabric, formed in the gap between the two sets, shows the face loops of one set on one side and the face loops of the other set on the opposite side of the fabric. A common form of single-faced fabric is a plain or single jersey fabric, whereas a common double-faced fabric is a rib fabric. In Figure 3A there is shown the formation of a 1x1 rib fabric, where it can be seen that the cylinder needles 82 draw newly formed face loops in the opposite direction through previously formed loops 84 than the dial needles 80

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which are transverse to the cylinder needles 82. As mentioned, a double-faced fabric is formed where the cylinder needles and dial needles draw portions of the same yarn 85 in opposite directions through respective previously formed loops 84. In contrast, Figure 3B shows the cylinder needles 82 and dial needles 80 each separately forming single-
5 faced stitches with separate respective yarns 92, 94.

The sequence of knitting stages illustrated in Figures 3A, 3B and 3C show the formation of a joined fabric according to preferred embodiments of the invention. Firstly a double-faced fabric portion is formed by knitting in the manner illustrated in Figure
10 3A. Then, by appropriate placement of control studs 28 in the control drum 8 (Figure 1) the cylinder needles 82 and dial needles 80 may be caused to each separately knit single-faced fabric portions, as shown in Figure 3B. The single-faced fabric knitted on the cylinder needles 82 are knitted onto the face loops 90 of the double-faced fabric, and the single-faced fabric created on the dial needles 80 are knitted onto the reverse loops
15 88. The two single-faced fabric portions may then be again joined into a single double-faced fabric by coordinating the cylinder and dial needles 82, 80, whereby the yarn 96 (Figure 3C) is drawn in opposite directions through the respective single faced loops 92, 94.

20 Figure 4 shows a knitted fabric joining portion 100, in accordance with a preferred embodiment of the invention. The joining portion 110 comprises a double-faced fabric portion 102 integrally knitted into first and second single-faced fabric portions 104, 106. Dark coloured yarn 108 shows the terminal double-faced course comprising face loops 112 and reverse loops 110. The first single-faced fabric portion 104 can be seen knitted
25 onto the face loops 112 of double-faced fabric portion 102, whilst the second single-faced fabric portion 106 is knitted onto the reverse loops 110. Clearly corresponding courses of the first and second single-faced fabric portions may thereafter be joined into a further double-faced fabric portion by utilising both the cylinder and dial needles to draw yarn in opposite directions through the respective loops thereof, such that the
30 terminal course loops of the first fabric portion 104 knit onto the face loops of the double-faced fabric, and the terminal course loops of the second fabric portion 106 knit onto the reverse loops of the double faced fabric. In this way, a length of knitted fabric

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may be formed in which a single double-faced fabric portion is integrally knitted into two single-faced fabric portions, which may then be integrally knitted again into a single double-faced fabric portion. A length of fabric formed in this way thus comprises two single layer fabric portions having an integrally knitted double fabric layer portion
5 therebetween.

A particularly advantageous application of a knitted fabric having an integrally knitted double layer section is found in the manufacture of undergarments, such as mens and womens briefs. Undergarments of this type are often formed from a rib fabric which
10 is stretchable along the courses of the fabric to allow better form fitting of the garment on the wearer. However it is often desirable to provide the undergarment with a double fabric layer gusset portion, such as at the front of a mens brief to provide increased support and absorption characteristics.

15 Figure 5 shows a pattern layout 120 for the construction of a mens brief. When the undergarment is constructed the sections 126 constitute the waistband, whilst the edges indicated by reference numeral 124 form the leg opening borders of the garment. Section 122 forms the rear of the undergarment when constructed, and section 128 constitutes the gusset region which is advantageously constructed from two layers of
20 fabric. Conventionally, large sheets of knitted fabric are layed out on a patterning table and portions of fabric corresponding to the undergarment pattern 120 and gusset portion 128 are cut therefrom. The undergarment is then constructed by sewing the gusset fabric to the undergarment pattern fabric at least along seam lines 127, and then forming the fabric into a brief by fixing elastic along the leg opening borders and waistband sections
25 and connecting the waistband sections 126.

A preferred embodiment of the present invention provides an alternative undergarment construction and method of constructing, which may be explained with reference to Figure 6. A tubular length of knitted fabric 130 is produced as described
30 herein, having an integrally knit double fabric layer section 134 interconnecting two single layer fabric sections 133 and 135. The single layer sections 133, 135 and the double layer section 134 are shown delineated by dash-dot lines 132

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in Figure 6. In order to form an undergarment pattern similar in construction to the pattern 120 in Figure 5, having an integrally formed double layer gusset region, all that is required is to cut the tubular fabric length 130 along the solid and dashed lines 131, whereby two patterned portions of fabric 136 are produced, for construction into undergarments. The portion of fabric 140 bordered by the leg opening borders 124 may be discarded.

The following sets forth the "programming" steps which may be required to produce a length of fabric 130 on a cylinder and dial knitting machine. The steps are set out in the manner of functions performed by way of control studs 28 placed in various rows of the control drum 8. The steps are in the context of a knitting machine having twelve sections, wherein a section comprises an individual yarn feeder 16 and associated knitting cams for each of the cylinder and the dial. Although twelve sections are provided, only eight sections are operative for knitting the body of the fabric length 130, namely sections 2, 3, 5, 6, 8, 9, 11 and 12. For forming the single layer sections 133, 135 (rib fabric) all eight knitting sections are utilised. During formation of the double layer portion 134, knitting sections 2, 5, 8 and 11 are utilised by the cylinder needles to form a single jersey fabric, whilst knitting sections 3, 6, 9 and 12 are utilised by the dial needles to form a separate single jersey fabric, the two single jersey fabrics being joined at integral double layer joins 132 as hereinbefore described. Rows 3 to 11 of the control drum relate to functions required for knitting two courses of interlocking fabric for an end of the fabric length 130. Row 16 relates to the introduction of a single course of dissolvable thread, such that a continuously formed length of knitted fabric may be easily dissociated into discrete garment fabric lengths 130 by dissolving the dissolvable thread course by way of, for example, a steam press. At rows 25 and 26 the eight operative knitting sections are set to knit with both cylinder and dial needles to form the first single layer section 133. Rows 31 to 39 act to set the knitting cams of alternate operative knitting sections to knit only on the cylinder needles or dial needles respectively, to form the double layer portion 134. Control drum rows 43 to 50 then return all of the operative the knitting sections to knitting both on the cylinder and dial needles together to form the final single layer rib fabric portion 135.

The knitting machine control steps are as follows:

- ROW 3 Cylinder clear lever placed in non knit position.
Dial clear release lever placed in all knit position.
- 5 Cylinder quality release lever opened to return to number 1 quality position.
Dial quality lever placed into number 3 quality position.
Control drum advance to row number 4, knitting sections number 1 transfer and number 2 knitting feed.
- 10
- ROW 4 Cylinder clear release lever placed into all knit position.
Dial clear lever placed into non knit position.
Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.
- 15 Cylinder quality lever placed into number 2 quality position.
Control drum advance to row number 5, knitting section number 3.
- ROW 5 Cylinder clear release lever placed into all knot position.
Dial clear lever placed into non knit position.
- 20 Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.
Cylinder quality lever placed into number 2 quality position.
Control drum advance to row number 6, knitting section number 5.
- 25 ROW 6 Cylinder clear release lever placed into all knot position.
Dial clear lever placed into non knit position.
Cylinder quality release lever place into position for cylinder quality lever to engage into number 2 quality position.
Cylinder quality lever placed into number 2 quality position.
- 30 Control drum advance to row number 7, section number 6.
- ROW 7 Cylinder clear lever placed into non knit position.

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- Dial clear release lever placed into all knot position.
 Cylinder quality release lever opened to return to number 1 quality position.
 Dial quality lever placed into number 3 quality position.
- 5 Control drum advance to row number 8, sections number 7 transfer and number 7 knitting feed.
- ROW 8 Cylinder clear lever placed into non knot position.
 Dial clear release lever placed into all knit position.
- 10 Cylinder quality release lever opened to return to number 1 quality position.
 Dial quality lever placed into number 3 quality position.
 Dial drum advance to row number 9, section number 9 knitting feed.
- 15 ROW 9 Cylinder clear release lever placed into all knit position.
 Dial clear release lever placed into all knit position.
 Cylinder quality release lever opened to return to number 1 quality position.
 Dial quality release lever opened to return to number 1 quality position.
- 20 Control drum advance to row number 10, section number 10 transfer and number 11 knitting feed.
- ROW 10 Dial clear lever placed into non knit position.
 Dial quality release lever opened to return to number 1 quality position.
- 25 Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.
 Control drum advance to row number 11, section number 12 knitting feed.
- ROW 11 Dial quality release lever opened to return to number 1 quality position.
 30- Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.
 Control drum advance to row 12 where no actions take place and then into

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- row 13 where the dwell pin is activated and control drum is now in a stationary position. The knitting machine is now in the process of knitting the locking courses prior to the introduction of a dissolvable drawthread. A total of 2 revolutions are knitted prior to operating the trip catch at number 7 position on the fabric length chain. When the catch is activated the control drum is advanced through row 14, section 9 and row 15, section 11 where no actions take place, taking up commencement of actions at row number 16, section number 12.
- 5
- 10 ROW 16 At this point striper number 1 height is introduced placing dissolvable thread into needles, with the release lever on striking lever box in raised position to disengage Number 2 height striper of the ground yarn for the purpose of one revolution of dissolvable thread.
- 15 ROW 17 Cylinder clear release lever placed into all knit position. This course is the pick up course or the first course of the start of the new piece of fabric following on to the welt courses and then into the (all needle) body. Control drum advance to row 18, section.
- 20 ROW 18 No actions take place on control drum.
- ROW 23 Control drum advance to row 24, section 12.
- ROW 24 At this point striper number 2 height is introduced placing ground yarn into needles and with the release lever on striking lever box in raised position to disengage number 1 height striper of the dissolvable thread. Control drum advances to row number 25 where the dwell pin is activated and now the control drum is in a stationary position whereas the machine is turning through knitting sections 2, 3, 5, 6, 8, 9, 11 and the sections of cylinder clear release levers placed into all knit and dial clear release levers placed into all knit.
- 25
- 30 - Dial quality release levers opened t return all section quality to number 1

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position, cylinder qualities release lever placed into position for cylinder qualities levers to engage into number 2 quality positions.

As section 12 approaches control drum chain stud at number 7 position on fabric length chain operates on trip catch, releasing dwell lever and the start of control drum racking to row 26 section 12.

5

ROW 26 Cylinder clear release lever placed into all knit position. Dial clear release lever placed into all knit, dial quality release lever opened to return to number 1 quality position, cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.

10

Control drum advances to row 27.

ROWS 27-28

15

No actions take place.

ROW 29 Dwell pin is activated and the control drum is now in a stationary position and no actions taking place. The machine is now in the process of making the first portion of 1+1 is knitted the control drum is brought into action and the process of the seamless double gusset to be started.

20

As the trip catch is activated by the fabric length chain the control drum advance takes place through row 30 section 9 where no action takes place and taking up commencement of actions at row 31, section 11.

25 ROW 31

Cylinder quality lever placed into number 3 position.

Dial clear lever placed in non knit position.

Control drum advance to row 32, section 12.

ROW 32

30-

Cylinder quality release lever placed into position for cylinder quality lever to engage into number 1 quality position.

Dial quality lever placed into number 3 quality position.

Cylinder clear lever placed into non knit position.

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Control drum advance to row 33, section 2.

- ROW 33 Cylinder quality release lever placed into number 3 quality position.
Dial clear lever placed in non knit position.
- 5 Control drum advance to row 34, section 3.
- ROW 34 Cylinder quality release lever placed into position for cylinder quality
lever to engage into number 1 quality position.
Dial quality lever placed into number 3 quality position.
- 10 Cylinder clear lever placed into non knit position.
Control drum advances to row 34, section 5.
- ROW 35 Cylinder quality lever placed into number 3 quality position.
Dial clear lever placed in non knit position.
- 15 Control drum advances to row 36, section 6.
- ROW 36 Cylinder quality release lever placed into position for cylinder quality
lever to engage into number 1 quality position.
Dial quality lever placed into number 3 quality position.
- 20 Cylinder clear lever placed into non knit position.
- ROW 37 Cylinder quality lever placed in number 3 quality position.
Dial clear lever place in non knit position.
Control drum advances to row 38, section 9.
- 25 Control drum advances to row 38, section 9.
- ROW 38 Cylinder quality release lever placed into position for cylinder quality
lever to engage into number 1 quality position.
Dial quality lever placed into number 3 quality position.
Cylinder clear lever placed into non knit position.
- 30 Control drum advances to row 39, section 11.
- ROW 39 Cylinder quality lever placed in number 3 quality position.

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Dial clear lever place in non knit position.

Control drum advances to row 40, section 12.

- 5 ROW 40 No actions take place and control drum advances to row 41 where the dwell pin is activated and the control drum is now in a stationary position and no actions taking place. The machine is now in the process of knitting separate single-jersey fabric portions on each of the cylinder and dial needles with sections 2, 5, 8 and 11 feeding yarn to the cylinder needles and sections 3, 6, 9 and 12 knitting with the dial needles.
- 10 The length of this part of the fabric is determined by the amount of links in the fabric length chain and may be altered by the increase or decrease of the amount of links in the chain providing this is done in multiples of 4. Once the desired length of the gusset is knitted the control drum is brought into action and the process of the second portion of the all needle rib is started.
- 15 As the trip catch is activated by the fabric length chain the control drum advances through row 42 section 9 where no action takes place and commences actions at row 43, section 11.
- 20 ROW 43 Dial clear release lever placed into all knit position.
Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.
Control drum advances to row 44, section 12.
- 25 ROW 44 Cylinder quality lever placed into number 2 quality position.
Dial quality release lever placed into position for dial quality lever to engage into number 1 quality position.
Cylinder clear release lever placed in all knit position.
Control drum advances to row 45, section 2.
- 30 ROW 45 Dial clear release lever placed into all knit position.
Cylinder quality release lever placed into position for cylinder quality

- 17 -

lever to engage into number 2 quality position.

Control drum advances to row 46, section 3.

5 ROW 46 Cylinder quality lever placed into number 2 quality position. Dial quality release lever placed into position for dial quality lever to engage into number 1 quality position. Cylinder clear release lever placed into all knit position.

Control drum advances to row 47, section 5.

10 ROW 47 Dial clear release lever placed into all knit position.
Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.

Control drum advances to row 48, section 6.

15 ROW 48 Cylinder quality lever placed into number 2 quality position. Dial quality release lever placed into position for dial quality lever to engage into number 1 quality position. Cylinder clear release lever placed into all knit position.

Control drum advances to row 49, section 8.

20

ROW 49 Dial clear release lever placed into all knit position.
Cylinder quality release lever placed into position for cylinder quality lever to engage into number 2 quality position.

Control drum advances to row 50, section 9.

25

ROW 50 Cylinder quality lever placed into number 2 quality position.
Dial quality release lever placed into position for dial quality lever to engage into number 1 quality position.

Cylinder clear release lever placed into all knit position.

30 -

Now that all knitting sections have been introduced the control drum racks through all rows where no actions take place and takes up position at row

- 18 -

number 60 where the dwell pin is activated and the control drum remains in a stationary position for the knitting of the final 1x1 rib (all needle knit) fabric portion.

- 5 The foregoing detailed description has been put forward merely by way of explanation only, and is not intended to be limiting to the invention, which includes every novel feature and novel combination of features disclosed herein.

10

CLAIMS

1. A knitted fabric comprising a first knitted fabric portion integrally knitted along a joining line into second and third knitted fabric portions.
5
2. A knitted fabric according to claim 1 wherein alternate loops or wales of the first portion are knitted to loops or wales of the second and third portions respectively.
3. A knitted fabric according to claim 1 or 2, which is formed in a single process on
10 an automated knitting machine.
4. A knitted fabric according to claim 1, 2 or 3 wherein the first knitted fabric portion is a double-faced weft knitted structure and the second and third knitted portions are each single-faced weft knitted structures.
15
5. A knitted fabric according to claim 4 wherein the first knitted portion is a rib fabric and the second and third knitted portions are each a jersey or plain fabric.
6. A knitted fabric according to any one of claims 1 to 5 wherein the second and
20 third knitted portions are integrally knitted along a second joining line into a fourth knitted fabric portion such that the section of knitted fabric between the joining lines comprises a double layer of fabric constituted by the second and third knitted fabric portions.
- 25 7. A knitted fabric comprising a single layer knitted fabric section integrally knitted into a double layer knitted fabric section.
8. A knitted fabric comprising a double layer fabric section integrally knitted between two single layer fabric sections.
30
9. A knitted undergarment of the type adapted to be worn around the groin region of a wearer comprising a double fabric layer gusset portion integrally knitted into the

- 20 -

fabric of the undergarment.

10. A process for producing a knitted fabric on a knitting machine having independent controllable first and second sets of knitting needles, comprising knitting a double-faced fabric portion utilising needles from both said first and second sets, and knitting onto an edge of said double faced fabric portion a double layer fabric consisting of two single faced fabric portions each knitted on needles from a respective one of the first and second sets.
11. A process for producing a knitted fabric on a knitting machine having independently controllable first and second sets of knitting needles comprising knitting two single faced fabric portions, one on each of the first and second sets of needles, and knitting the two single faced fabric portions together into a double faced fabric portion by utilising both the first and second sets of needles.
12. A process according to claim 10 or 11 in which a plurality of feeder mechanisms are provided which, in use, feed thread or yarn to be knitted wherein during knitting of said two single faced fabric portions, thread or yarn from alternate feeder mechanisms are fed to the first and second sets of needles respectively.
13. A process according to claim 10, 11 or 12 wherein the double faced fabric portion is a rib fabric and the two single faced fabric portions are each a jersey fabric and are knitted into the face loops and the reverse loops respectively where the double faced and single faced fabrics join.
14. A method of controlling a knitting machine having two sets of independently controllable knitting needles comprising controlling both of the sets of needles so as to knit a double faced fabric and then controlling the two sets of needles so as to knit a single faced fabric on each set of needles such that each single faced fabric is integrally knitted with said double faced fabric whereby to produce a single layer knitted fabric integrally knitted into a double layer knitted fabric.

- 21 -

15. A method of controlling a knitting machine having two sets of independently controllable knitting needles comprising controlling the sets of needles so as to knit a single faced fabric on each set of needles and then controlling both sets of needles so as to integrally knit a double faced fabric onto respective edges of the single faced fabrics
5 whereby to produce a double layer knitted fabric integrally knitted into a single layer knitted fabric.
16. A method of producing fabric an undergarment of the type adapted to be worn around the groin region of a wearer, comprising knitting a length of fabric having an
10 integrally knitted double layer fabric section and patterning the length of fabric such that a portion of the double layer fabric section is designated to become a gusset portion in the completed undergarment.

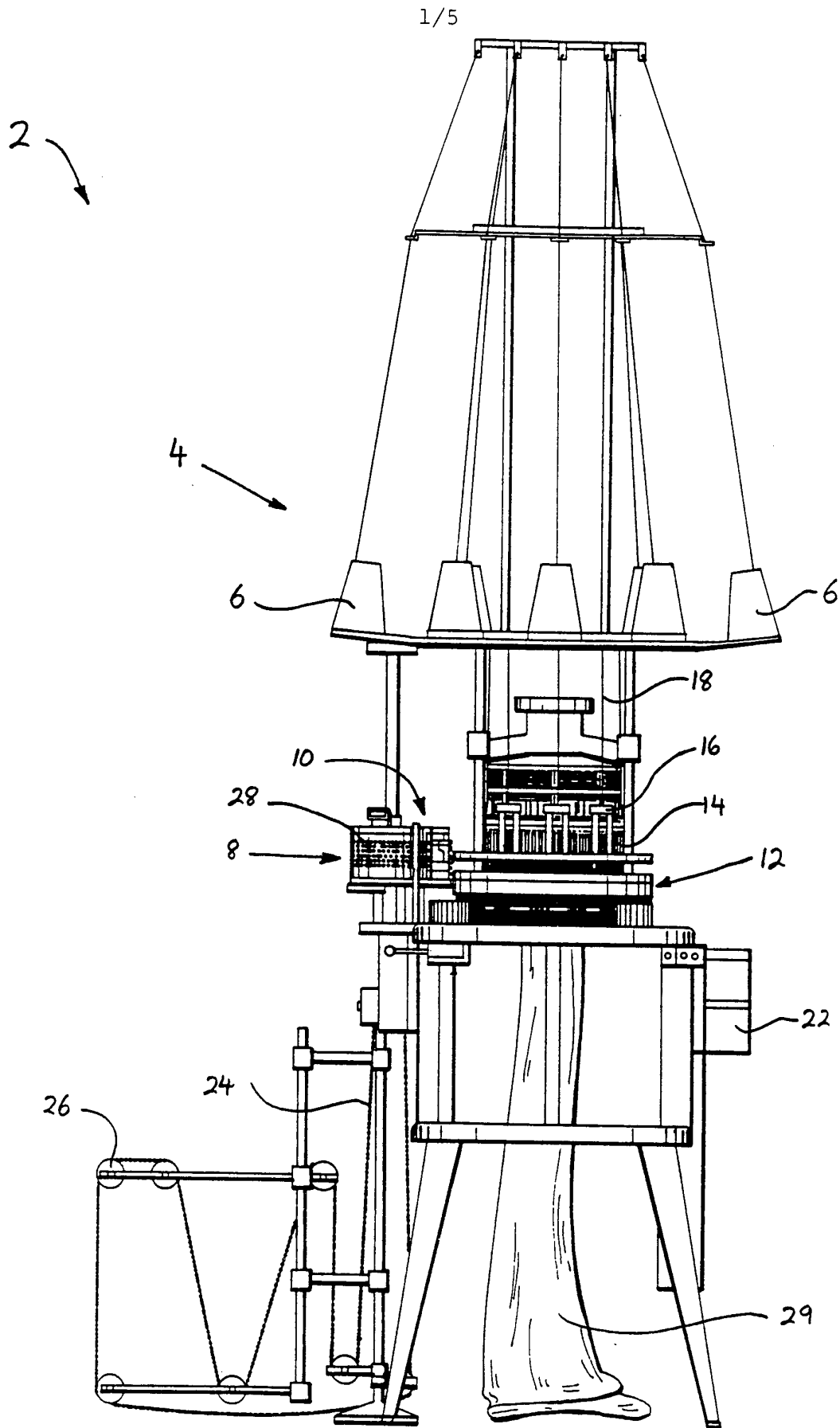


Figure 1

40 →

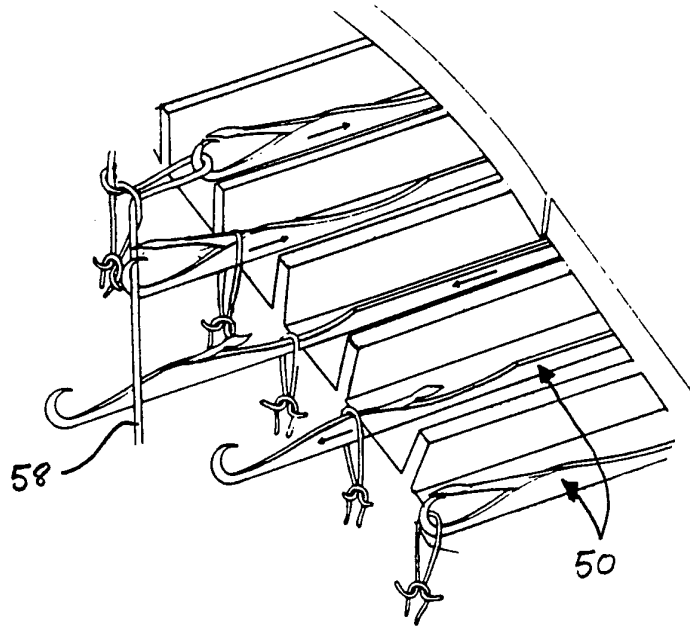


Figure 2B

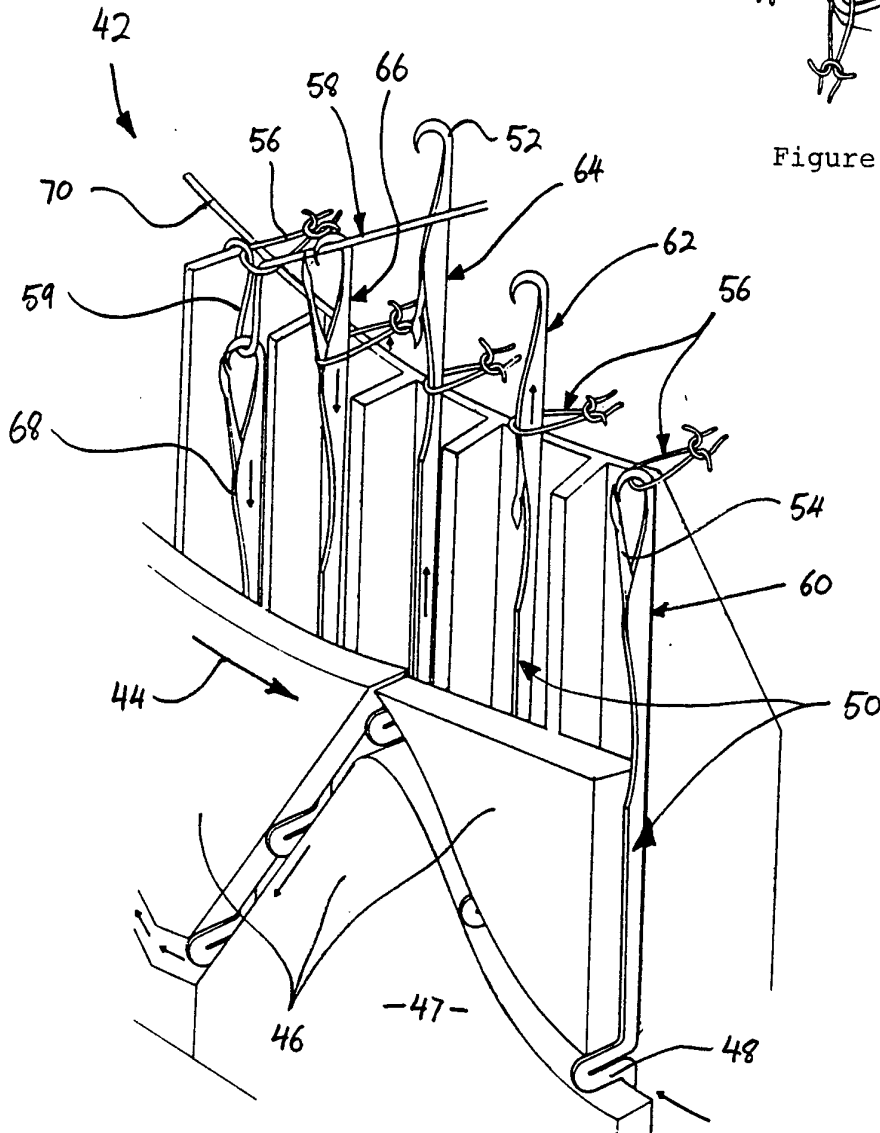


Figure 2A

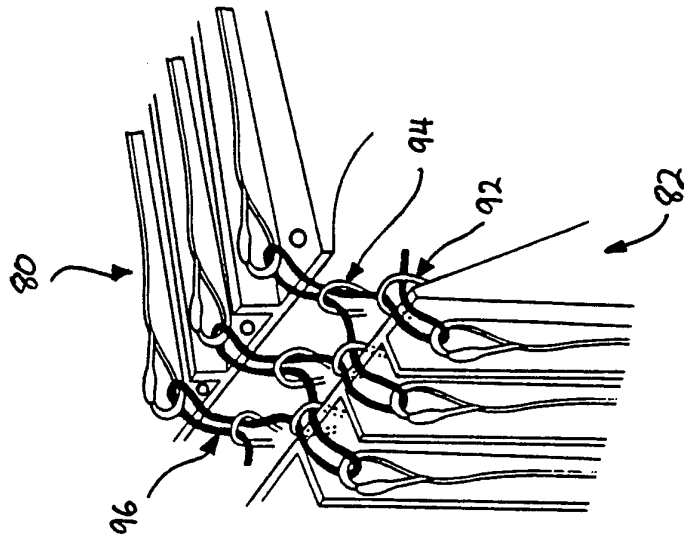


Figure 3C

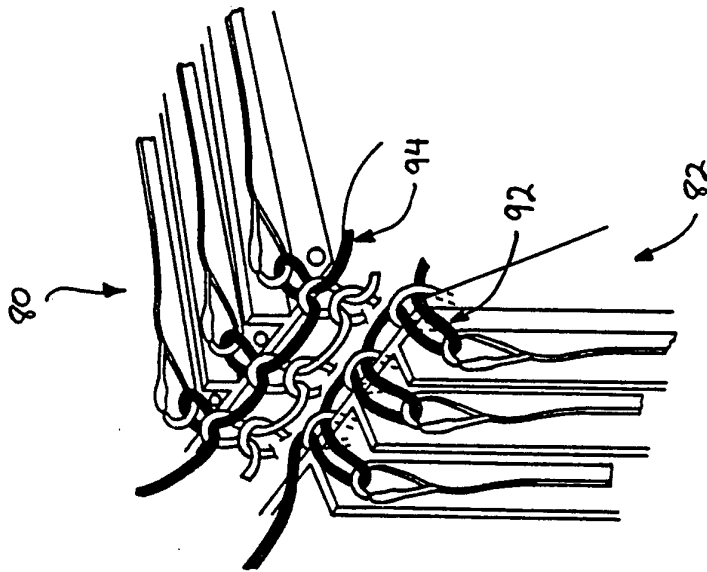


Figure 3B

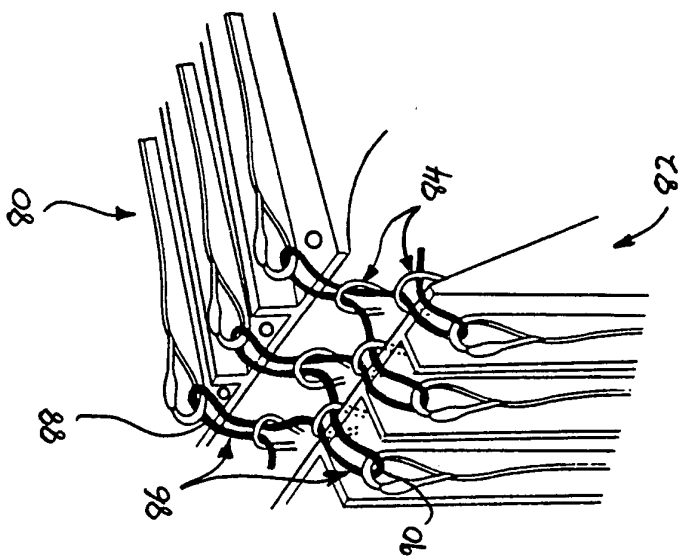


Figure 3A

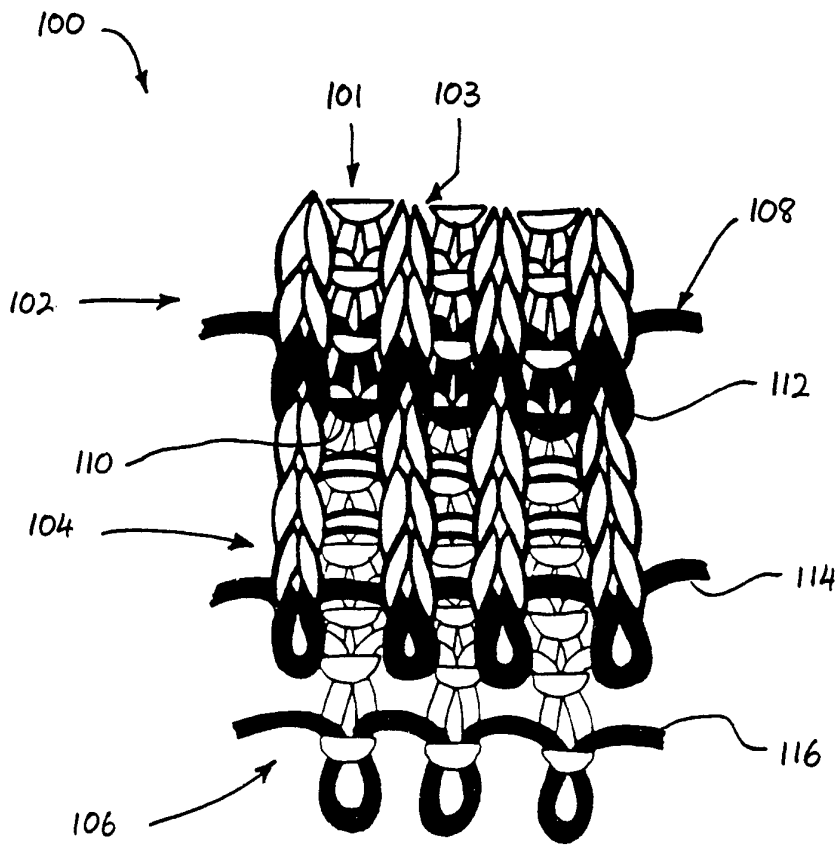


Figure 4

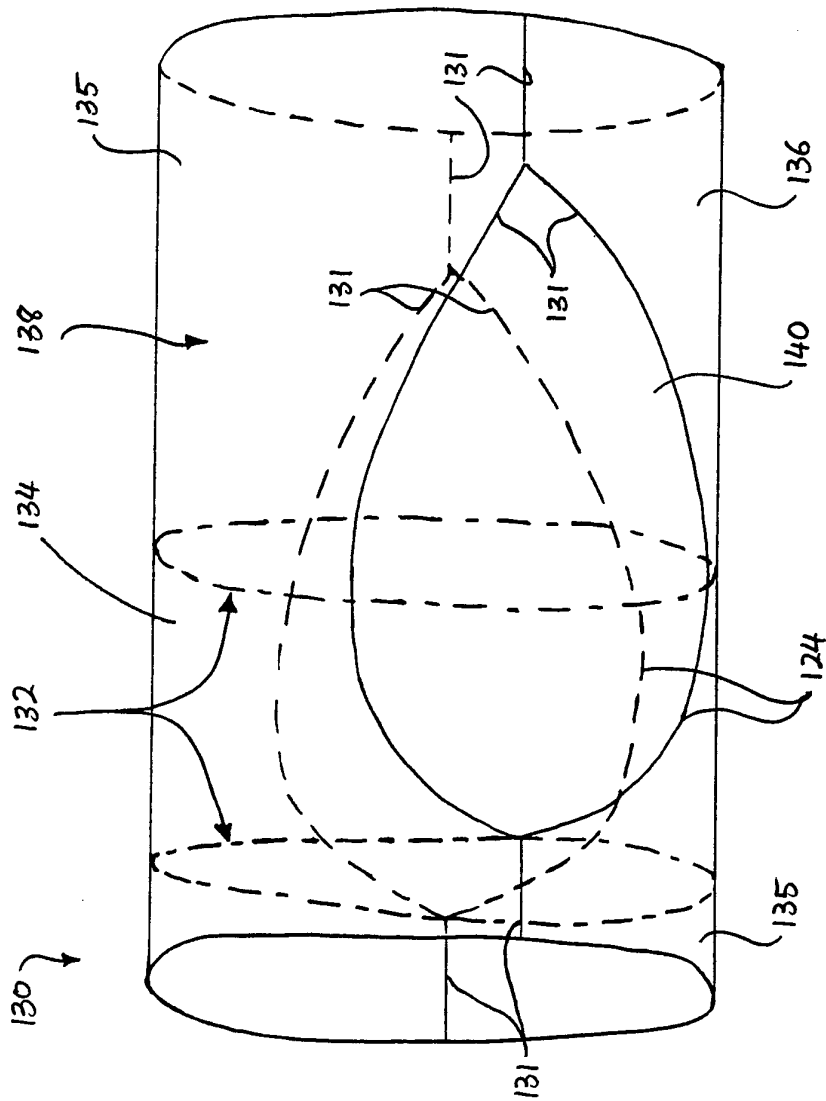


Figure 6

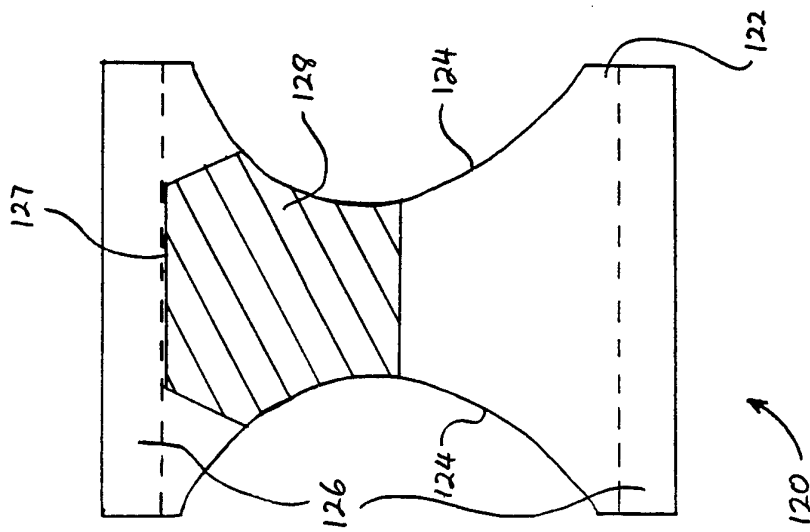
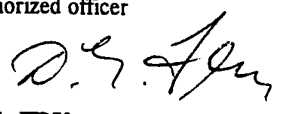


Figure 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 93/00642

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl. ⁵ A41B 9/02, D04B 9/42 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 A41B 9/02, 9/04, D04B 1/24, 7/04, 7/30, 9/00, 9/42 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : IPC as above Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)																						
C. DOCUMENTS CONSIDERED TO BE RELEVANT																						
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.																				
X	US,A, 5163306 (BOEHM et al) 17 November 1992 (17.11.92) column 3	1,7,9																				
X	US,A, 4043156 (PERNICK) 23 August 1977 (23.08.77) column 2 lines 9-24	1																				
X	US,A, 3109301 (GARROU et al) 5 November 1963 (05.11.63) column 2	1																				
X	US, 3109300 (GARROU et al) 5 November 1963 (05.11.63) columns 2-3	1																				
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.																						
* Special categories of cited documents : <table border="0"> <tr> <td>"A"</td> <td>document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T"</td> <td>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</td> </tr> <tr> <td>"E"</td> <td>earlier document but published on or after the international filing date</td> <td>"X"</td> <td>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</td> </tr> <tr> <td>"L"</td> <td>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y"</td> <td>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</td> </tr> <tr> <td>"O"</td> <td>document referring to an oral disclosure, use, exhibition or other means</td> <td>"&"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"P"</td> <td>document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			"A"	document defining the general state of the art which is not considered to be of particular relevance	"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	"E"	earlier document but published on or after the international filing date	"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	"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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	"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family	"P"	document published prior to the international filing date but later than the priority date claimed		
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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																			
"E"	earlier document but published on or after the international filing date	"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																			
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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																			
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family																			
"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 28 March 1994 (28.03.94)		Date of mailing of the international search report 7 April 1994 (7.4.94).																				
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929		Authorized officer  D.G. FRY Telephone No. (06) 2832130																				

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
A	US,A, 3093988 (RUTLEDGE) 18 June 1963 (18.06.63) columns 2-3	-
A	US,A, 3026697 (RUTLEDGE) 27 March 1962 (27.03.62) columns 2-3	
A	US,A, 2898754 (HARMS) 11 August 1959 (11.08.59) column 3 line 50 - column 4 line 9	
A	GB,A, 1460670 (BILLI SpA) 6 January 1977 (06.01.77) page 2	
A	EP,A, 446583 (STOLL GmbH) 18 September 1991 (18.09.91) Abstract	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU 93/00642

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US	5163306	EP	516905		
US	4043156	CA	1044481	DE	2656403
		FR	2338340	GB	1536759
		JP	52088435	ES	454706
				IT	1067017
GB	1460670	DE	2416762	ES	424944
		IT	982085	JP	49126953
FR	2224575				
EP	446583	DE	4008057	US	5284031
END OF ANNEX					