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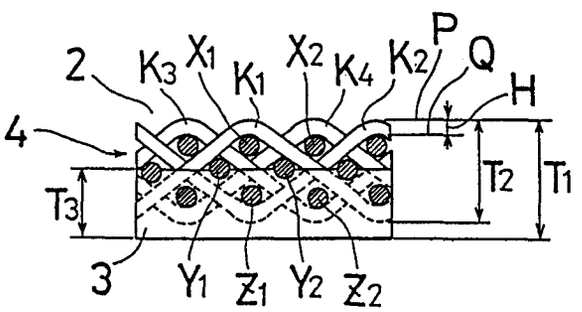
(54) Endless belt.

(57) An endless belt for the extended nip press of the press part in the papermaking process, wherein the endless belt is composed of a base fabric (4) and a layer of an elastic material (3) coated on one side thereof, the base fabric (4) being a warp multitude layer fabric which is made endless by hollow weaving, and the exposed side (2) of the base fabric (4) having such a structure that the plane (Q) formed by connecting the apexes of the winding of the yarns in the belt running direction (α) is at a lower position than the plane (P) by connection the apexes of the winding of the yarns in the direction (β) transversely across the belt running direction.



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ENDLESS BELT

BACKGROUND OF THE INVENTION

1) Field of the Invention:

The present invention relates to an endless belt and particularly to the base fabric structure of an endless belt used for the extended nip press (called as ENP hereafter) in the press part of papermaking process.

2) Description of the prior Art:

In the press part of papermaking process, either a roll press or an ENP is used, and the latter is becoming popular because of many advantages.

The extended nip press is a dewatering press consisting of a rotating roll and a pressure shoe. Dewatering is accomplished by pressing the pressure shoe through the endless belt for ENP in contact with said roll against the roll while a web of wet paper sandwiched between two sheets of felt is passed between them.

Conventional belts for the extended nip press have such a structure that a flat base fabric of multiple layer weave of synthetic fiber is jointed endless by fabric seaming technology and a layer of elastic material is formed on one side thereof. In use, that side of the belt on which is formed the layer of elastic material is in sliding contact with the pressure shoe and the other side of the belt which

is the base fabric side exposed, contacts with the felt.

Since the conventional belt is made endless by joining the ends of a flat base fabric of multiple layer weave of synthetic fiber, it has a disadvantage of forming the joint mark on the wet paper. Moreover, the seam is not uniform with other parts in fabric structure and yarn density to decrease the strength of the seam.

In order to increase the strength of the seam, it is necessary to make such a structure that the yarns in the belt running direction (referred to as lengthwise yarns hereinafter) wind sufficiently to twine them fully. The structure is realized by a multiple weft weaving fabric in which the lengthwise yarns wind to a large extent throughout the entire belt. On the other hand, the yarns in the direction transversely across the belt running direction (referred to as crosswise yarns hereinafter) do not need a high strength. Therefore, it is not necessary for the crosswise yarns to wind in the transverse direction. According to such a structure, the apexes of the winding of the lengthwise yarns project outside the crosswise yarns. This means that the lengthwise yarns come into direct contact with the felt and wear out sooner than the crosswise yarns. In other words, the conventional endless belt formed by seaming a flat base fabric of multiple layer weave is at a disadvantage that the yarns which need strength most wear out soon.

This disadvantage would be inevitable even in the

case of base fabric of multiple layer weave as disclosed in UK Patent Nos. 2106555A and 2106557A.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an endless belt composed of a base fabric and a layer of elastic material covering one side of the base fabric, characterized in that the base fabric is of endless multiple layer hollow weave, with the uncovered side thereof having such a structure that the plane formed by connecting the apexes of the winding of the lengthwise yarns is at a lower position than that formed by connecting the apexes of the winding of the crosswise yarns.

The endless belt of this invention which is made endless by hollow weaving as mentioned above does not have the seam which differs in structure, thickness, and air permeability from the rest of the base fabric. Therefore, it has no possibility of giving seam marks to paper when it is used as a belt for an ENP. Moreover, according to this invention, the exposed side of the base fabric of the endless belt has such a structure that the crosswise yarns are disposed outside the lengthwise yarns, so that the lengthwise yarns are protected by the crosswise yarns. When the endless belt of this invention is used for an

ENP , the crosswise yarns, which are not subjected to high tension, will wear out as the result of contact with the felt, but the lengthwise yarns, which are subjected to high tension, will not wear out. This extends the life time of the belt and permits the belt to perform dewatering in a stable manner over a long period of time.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of an example of the endless belt of this invention.

Fig. 2 is a partly enlarged sectional view taken along the line A-A' of Fig. 1.

Fig. 3 (a), (b), and (c) are a sectional view of the structure of the base fabric, a sectional view illustrating the weaving process, and a weave pattern of the base fabric, respectively.

Figs. 4 to 6 are those figures of another examples of the base fabric which correspond to Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The base fabric for the endless belt of this invention is produced by hollow multiple layer weaving, with the crosswise yarns being warps and the lengthwise yarns being wefts. The lengthwise yarns should be woven in two to four layers. In hollow weaving, an inner temple is used to make the warp density at both selvedges of

hollow woven fabric even with that in other parts. The hollow weave thus produced is cut to the fixed length to give the base fabric of the endless belt. The base fabric is undergone heat setting with infrared rays or a hot cylinder under a predetermined amount of stretching. Tension to be applied to the lengthwise yarns is 4 to 7 kg per centimeter of the belt width. Heat treatment is performed at 130 to 170°C for 30 to 120 seconds.

The base fabric is woven of monofilaments or multifilaments of 6-nylon, 6,6-nylon, 6,10-nylon, 12-nylon, aromatic polyamide, or polyester or the like.

In the case of double layer fabric, the lengthwise yarns in the exposed side of the base fabric should be monofilaments 0.25 mm to 0.6 mm in diameter in order that the base fabric has as much strength and thickness as required. The lengthwise yarns in the coated side of the base fabric should be textured mutifilament yarns, nylon spun yarns, or polyester spun yarns of 1000 to 4000 denier in order that they are balanced with the above-mentioned monofilaments or multifilaments and the base fabric has as much air permeability as required. The number of yarns in each layer is 5 to 30 per centimeter depending on the thickness, strength, and air permeability required.

According to this invention, the most preferred

embodiment of multiple layer fabric is triple layer fabric. In triple layer fabric, the lengthwise yarns on the exposed side of the base fabric are the same as those in the above-mentioned double layer fabric; and the lengthwise yarns on the coated side of the base fabric should be monofilaments 0.25 to 0.6 mm in diameter or mutifilaments of 450 to 3500 denier or twisted yarns thereof in order to ensure good adhesion with an elastic material. The yarns of the intermediate layer sandwiched between the two layers should be the same as the lengthwise yarns on the coated side of the above-mentioned double layer fabric. The number of yarns in each layer should preferably be 5 to 12 per centimeter.

In the case of quadruple layer weave, the lengthwise yarns in the exposed layer and the adjacent layer thereof should be the same as those in the exposed layer of the above-mentioned triple layer weave, and the lengthwise yarns in the third layer (from the exposed layer) and the coated layer should be the same as those in the intermediate layer and the coated layer of the above-mentioned triple layer weave, respectively. The number of yarns in each layer should be the same as that in the case of triple layer weave. The crosswise yarns should be monofilaments 0.3 to 0.7 mm in diameter and the number of yarns should be 12 to 24 per centimeter in order that

the base fabric has proper thickness, wear resistance, and running stability.

The layer of elastic material should preferably be made of polyurethane, acrylonitrile-butadiene copolymer, ethylene-acrylate copolymer, fluorinated hydrocarbons, epichlorohydrin rubber, polyester elastomer, plasticized polyvinyl chloride, or thermoplastic polyurethane.

The surface of the layer of elastic material should preferably be roughened with a grindstone or the like so that it has an improved adhesion for lubricant.

The yarns on the exposed side of the base fabric should preferably be coated with wear-resistant film, low-friction film, or water-proof film made of fluorocarbon resin, silicone resin, fluorine-containing epoxy resin, or polyurethane resin.

The base fabric produced as mentioned above should have such a structure that the plane formed by connecting the apexes of the winding of the lengthwise yarns is at a lower position than that formed by connecting the apexes of the winding of the crosswise yarns, the distance between the two planes being 0.11 to 0.33 mm. This structure is preferred from the standpoint of strength and wear resistance. The air permeability (measured according to JIS L-1079-1976) should preferably be 20 to 100 $cm^3/cm^2/sec$ from the standpoint of forming

the layer of elastic material. If the air permeability is less than 20 $cm^3/cm^2/sec$, air is entrapped in the layer of elastic material; and if it is in excess of 100 $cm^3/cm^2/sec$, the elastic material passes through the base fabric during the coating process.

The layer of elastic material can be formed by applying an elastic material to one side of the base fabric and grinding to a desired thickness after curing. It is necessary to take care that the elastic material does not penetrate the base fabric. One way of controlling the penetration is to use a fast-curing elastic material, and the other way is to use textured yarns as mentioned above. Textured yarns may be replaced by singed spun yarns. (Singeing is required to eliminate fluff that forms bubbles in the layer of elastic material.)

After curing, the layer of elastic material is finished to a desired thickness by grinding and at the same time the surface thereof is roughened. The grindstone for this grinding and roughening is one which is made of green silicon carbide (JIS designation: GC) having an average diameter of 840 to 500μm (JIS designation: grain size 24). This grindstone gives a surface roughness of about Rmax 20μm. After the layer of elastic material has been formed, the exposed side of the base fabric should be coated with wear-resistant

film, low-friction film, or water-proof film by spraying or dipping.

According to this invention, the base fabric of the endless belt is made by hollow weaving. Thereofore, the endless belt of this invention is free of the seam which has caused problems in the conventional endless belt. Moreover, because it is made by multiple warp weave in which the apexes of the winding of the lengthwise yarns are lower than those of the crosswise yarns, this structure permits the crosswise yarns to protect the lengthwise yarns under tension from wearing. Thus the endless belt of this invention is remarkably improved in the life time.

The endless belt of this invention is similar to the conventional one in that the base fabric is of endless multiple layer weave; but it is characterized in that the base fabric is made endless by hollow weaving, not by seaming. Therefore, the endless belt of this invention does not have the seaming at which irregular force is applied. It is superior in strength and other aspects to the known endless belt for the ENP.

The endless belt of this invention was compared with a conventional one by flex test under the following

conditions (in accordance with JIS K-6323).

Test piece of endless belt: 30 mm wide by 500 mm long

Stroke of flexing: 130 mm

Rate of flexing: 180 times/minute

Ambient temperature: 25 to 35°C

Load: 100 kg

The conventional endless belt became unusable due to excessive wear of the yarns in the running direction after 500,000 time of flexing; whereas the endless belt of this invention withstood 1,000,000 times of flexing at which there was no sign of wear on the yarns in the belt. In other words, it is expected that the endless belt of this invention has a service life which is longer than twice that of the conventional one.

EXAMPLE 1

In Fig. 1, there is shown an example of the endless belt (1) of this invention in which the base fabric is of triple warp weave. The length in the belt running direction (α) is 7.62 m and the width in the transverse direction (β) is 4.76 m. The outside is the exposed side (2) of the base fabric and the inside is the polyurethane rubber layer (3).

Fig. 2 is a sectional view taken along the line A-A' of Fig. 1. The thickness T_1 of the endless belt (1) is 2.7 mm, the thickness T_2 of the base fabric (4) is 1.76 mm, and the thickness T_3 of the polyurethane rubber

layer (3) is 2.2 mm. The lengthwise yarns (in the running direction (α)) form three layers, i.e., the layer of the exposed side (x_1, x_2, ...), the intermediate layer (y_1, y_2, ...), and the layer adjacent to the polyurethane rubber layer (z_1, z_2, ...). The crosswise yarns (in the transverse direction (β)) (k_1, k_2, ...) pass outside the lengthwise yarns (x_1, x_2, ... and z_1, z_2, ...).

The imaginary plane (P) on the exposed side (2) is in contact with the apexes of the bends of the crosswise yarns (k_1, k_2, ...). The imaginary plane (Q) is in contact with the apexes of the bends of the lengthwise yarns (x_1, x_2, ...). The distance (H) between the plane (P) and the plane (Q) is 0.21 mm.

Fig. 3 shows the detailed structure of the base fabric (4). In Fig. 3(a), the crosswise yarns (k_1, k_2, ...) are nylon monofilaments 0.47 mm in diameter, which are set as the warp on the loom. The lengthwise yarns (x_1, x_2, ...) in the upper layer are nylon monofilaments 0.37 mm in diameter; the lengthwise yarns (y_1, y_2, ...) in the middle layer are textured yarns of 1600 denier nylon multifilaments; and the lengthwise yarns (z_1, z_2, ...) in the lower layer are nylon monofilaments 0.37 mm in diameter. These lengthwise yarns are set as weft on the loom. The thus set warps and wefts undergo hollow

weave according to the weave pattern shown in Fig. 3(c). The warps become the crosswise yarns in the transverse direction (β) and the wefts become the lengthwise yarns in the running direction (α).

Tables 1-1 to 1-3 shows the characteristic properties of the base fabric (4) and other base fabrics which are the same in structure as the base fabric (4) but are made of different kinds of yarns.

EXAMPLE 2

Fig. 4 shows another example of triple layer weave which is different from that shown in Fig. 3. In this example, the crosswise yarns (k_2 and k_4) weave through the lengthwise yarns (x_1, x_2, ... and z_1, z_2, ...), and the crosswise yarn (k_1) weaves through the lengthwise yarns (x_1, x_2, ...) and the crosswise yarn (k_3) weaves through the lengthwise yarns (z_1, z_2, ...). Since the yarns (k_1 and k_3) bend obtuse and the area in contact with the felt is large, the base fabric of this structure is superior in wear resistance.

In this example, the lengthwise yarns (x_1, x_2, ...) at the exposed side of the base fabric are nylon monofilaments 0.43 mm in diameter; the lengthwise yarns (y_1, y_2, ...) in the middle layer are textured yarns of 1600 denier nylon multifilaments; and the lengthwise

yarns (z_1, z_2, ...) in the layer adjacent to the polyurethane rubber layer are nylon monofilaments 0.43 mm in diameter. The crosswise yarns (k_1, k_2, ...) are nylon monofilaments 0.52 mm in diameter. Table 2 shows the characteristic properties of the base fabric of this example. The base fabric was woven according to the weave pattern shown in Fig. 4(c). The base fabric was made into the endless belt having the same length and width as in Fig.3.

EXAMPLE 3

Fig. 5 shows a base fabric of quadruple layer weave in which the lengthwise yarns (x_1, x_2, ...; y_1, y_2, ...; z_1, z_2, ...; and w_1, w_2,...) are disposed in four layers.

In this example, the lengthwise yarns (x_1, x_2, ...) at the exposed side of the base fabric are nylon monofilaments 0.35 mm in diameter; the lengthwise yarns (y_1, y_2, ...) in the first middle layer are nylon monofilaments 0.35 mm in diameter; the lengthwise yarns (w_1, w_2, ...) in the second middle layer are 1600 denier polyester spun yarn; and the lengthwise yarns (z_1, z_2, ...) in the layer adjacent to the polyurethane rubber layer are nylon monofilaments 0.35 mm in diameter. The crosswise yarns (k_1, k_2, ...) are nylon monofilaments 0.52 mm in diameter. Table 3 shows the characteristic properties of the base fabric of this example. The base fabric was woven according to the weave pattern shown in Fig. 5(c).

The base fabric was made into the endless belt having the same lenght and width as the one shown in Fig. 1.

EXAMPLE 4

Fig. 6 shows a base fabric of double layer weave in which the lengthwise yarns (x and y) are disposed in two layers.

In this example, the lengthwise yarns (x) at the exposed side of the base fabric are textured yarns of 1600 denier nylon monofilaments, and the lengthwise yarns (y) in the layer adjacent to the polyurethane rubber layer are nylon monofilaments 0.52 mm in diameter. The crosswise yarns (k_1 and k_2) are nylon monofilaments 0.52 mm in diameter.

Table 4 shows the characteristic properties of the base fabric of this example. The base fabric was woven according to the design shown in Fig. 6(c). The base fabric was made into the endless belt having the same length and width as the one shown in Fig. 1.

Table 1-1
(Example 1)

Characteristic Properties of Base Fabric

Lengthwise yarns,	"x"	Nylon monofilament 0.37 mm in diameter
	"y"	Textured yarns of 1600 denier nylon multifilament
	"z"	Nylon monofilament 0.37 mm in diameter
Crosswise yarns		Nylon monofilament 0.47 mm in diameter
Mesh (number of yarns per centimeter)		Warp : 27.2
		Weft : 16.9
Thickness (mm)		1.76
Weight (g/m^2)		833
Air permeability ($cm^3/cm^2/sec$)		56
Strength (kg/cm)		
at 1% elongation		3.8
at 2% elongation		6.3
at 5% elongation		16.3
at 10% elongation		36.7
at break		141.3
Sample size		
Length (cm) :		20
Width (mm) :		10
number of sample :		3

Table 1-2

(Example 1)

Characteristic Properties of Base Fabric

Lengthwise yarns,	"x"	Nylon monofilament 0.43 mm in diameter
	"y"	1600 denier polyester twisted yarn
	"z"	Nylon monofilament 0.43 mm in diameter
Crosswise yarns		Nylon monofilament 0.47 mm in diameter
Mesh (number of yarns per centimeter)		Warp : 24.4
		Weft : 16.5
Thickness (mm)		2.06
Weight (g/m^2)		948
Air permeability ($cm^3/cm^2/sec$)		76
Strength (kg/cm)		
at 1% elongation		4.8
at 2% elongation		10.2
at 5% elongation		25.2
at 10% elongation		58.0
at break		173.8
Sample size		
Length (cm) :		20
Width (mm) :		10
number of sample :		3

Table 1-3
(Example 1)

Characteristic Properties of Base Fabric

Lengthwise yarns,	"x"	Polyester monofilament 0.40 mm in diameter
	"y"	1600 denier polyester twisted yarn
	"z"	Polyester monofilament 0.40 mm in diameter
Crosswise yarns		Nylon monofilament 0.47 mm in diameter
Mesh (number of yarns per centimeter)		Warp : 27.2
		Weft : 16.1
Thickness (mm)		1.94
Weight (g/m^2)		994
Air permeability ($cm^3/cm^2/sec$)		65
Strength (kg/cm)		
at 1% elongation		12.9
at 2% elongation		26.1
at 5% elongation		46.7
at 10% elongation		65.4
at break		152.0
Sample size		
Length (cm) :		20
Width (mm) :		10
number of sample :		3

Table 2
(Example 2)

Characteristic Properties of Base Fabric

Lengthwise yarns,	"x"	Nylon monofilament 0.43 mm in diameter
	"y"	Textured yarns of 1600 denier nylon multifilament
	"z"	Nylon monofilament 0.43 mm in diameter
Crosswise yarns		Nylon monofilament 0.52 mm in diameter
Mesh (number of yarns per centimeter)		Warp : 24.0
		Weft : 16.5
Thickness (mm)		2.10
Weight (g/m^2)		900
Air permeability ($cm^3/cm^2/sec$)		65
Strength (kg/cm)		
at 1% elongation		4.5
at 2% elongation		9.8
at 5% elongation		24.0
at 10% elongation		56.0
at break		170.4
Sample size		
Length (cm) :		20
Width (mm) :		10
number of sample :		3

Table 3

(Example 3)

Characteristic Properties of Base Fabric

Lengthwise yarns,	"x"	Nylon monofilament 0.35 mm in diameter
	"y"	Nylon monofilament 0.35 mm in diameter
	"w"	1600 denier polyester spun yarn
	"z"	Nylon monofilament 0.35 mm in diameter
Crosswise yarns		Nylon monofilament 0.47 mm in diameter
Mesh (number of yarns per centimeter)		Warp : 33.1
		Weft : 16.5
Thickness (mm)		2.40
Weight (g/m^2)		1100
Air permeability ($cm^3/cm^2/sec$)		40
Strength (kg/cm)		
at 1% elongation		6.0
at 2% elongation		13.4
at 5% elongation		40.3
at 10% elongation		84.5
at break		238.2
Sample size		
Length (cm) :		20
Width (mm) :		10
number of sample :		3

Table 4
(Example 4)

Characteristic Properties of Base Fabric

Lengthwise yarns, "x"	Textured yarn of 1600 denier nylon multifilament
"y"	Nylon monofilament 0.52 mm in diameter
Crosswise yarns	Nylon monofilament 0.52 mm in diameter
Mesh (number of yarns per centimeter)	Warp : 29.5
	Weft : 16.5
Thickness (mm)	2.00
Weight (g/m^2)	950
Air permeability ($cm^3/cm^2/sec$)	40
Strength (kg/cm)	
at 1% elongation	3.5
at 2% elongation	7.2
at 5% elongation	19.3
at 10% elongation	40.1
at break	150.5
Sample size	
Length (cm) :	20
Width (mm) :	10
number of sample :	3

CLAIMS

1. An endless belt (1) composed of a base fabric (4) and a layer of an elastic material (3) covering one side of the base fabric (4), characterized in that the base fabric (4) is of endless and hollow multiple layer weave, with the uncovered side (2) thereof having such a structure that the plane (Q) formed by connecting the apexes of the winding of the yarns in the belt running direction (α) is at a lower position than the plane (P) formed by connecting the apexes of the winding of the yarns in the direction (β) transversely across the belt running direction (α).

2. An endless belt according to Claim 1 wherein the distance (H) between the plane (Q) which is in contact with the apexes of the winding of the yarns in the belt running direction (α) and the plane (P) which is in contact with the apexes of the winding of the yarns in the directions (β) transversely across the belt running direction is 0.11 to 0.33 mm.

3. An endless belt according to Claim 1 or Claim 2 wherein the multiple layer weave of the base fabric is triple layer weave in which the yarns in the belt running direction (α) are disposed in three layers.

4. An endless belt according to Claim 3 wherein the yarns in the belt running direction in the layer adjacent to the layer of elastic material are nylon monofilaments or polyester monofilaments 0.25 to 0.6 mm in diameter, the yarns in the belt running direction in the layer next close to the layer of elastic material are textured yarns of 1000 to 4000 denier nylon multifilament or nylon or polyester spun yarns, and the yarns in the belt running direction in the layer farthest from the layer of elastic material are nylon monofilaments or polyester monofilaments 0.25 to 0.6 mm in diameter, and the number of the yarns in each layer is 5 to 12 per centimeter.

5. An endless belt according to anyone of Claims 1 to 4 wherein the yarns in the direction transversely across the belt running directions are nylon monofilaments 0.3 to 0.7 mm in diameter and the number of the yarns is 12 to 24 per centimeter.

6. An endless belt according to anyone of Claims 1 to 5 wherein the layer of elastic material is formed by applying polyurethane elastomer to one side of the woven base fabric and permetting it to penetrate into the base fabric to such an extent that it does not reach the other side of the base fabric.

7. An endless belt according to anyone of Claims 1 to 6 wherein the yarns which are exposed on the exposed side of the base fabric are coated with wearresistant film.

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FIG. 1

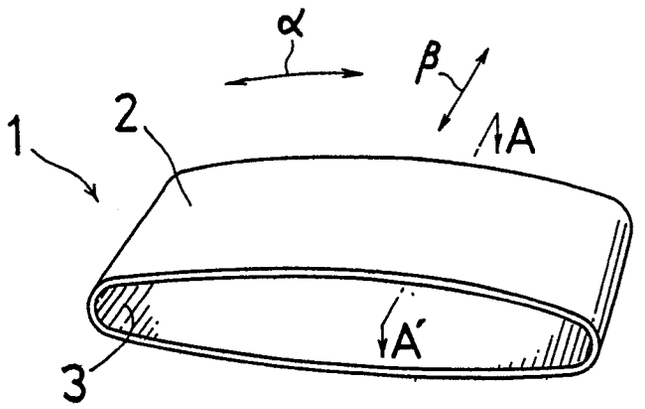

FIG. 2

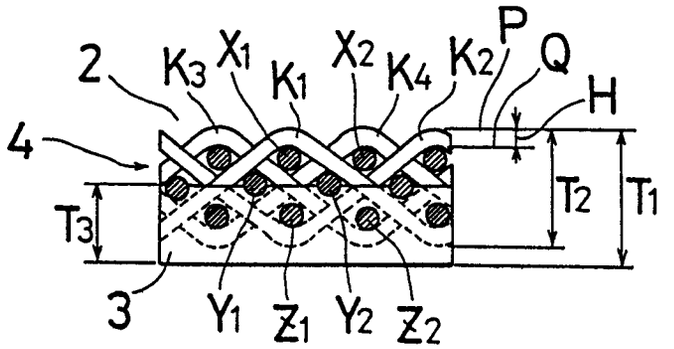

FIG. 3

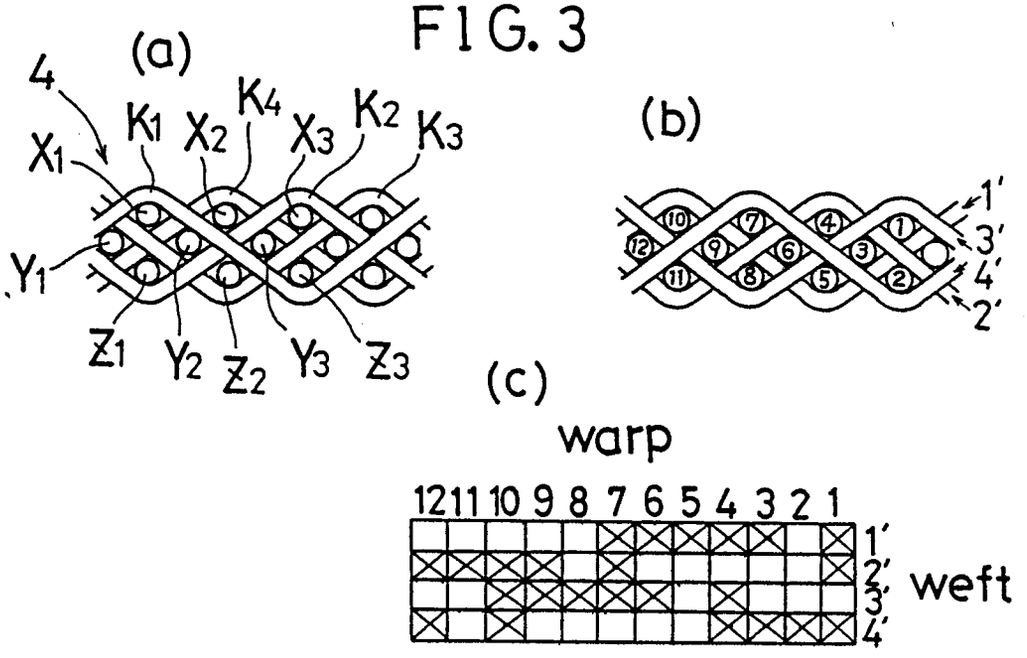

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FIG. 4

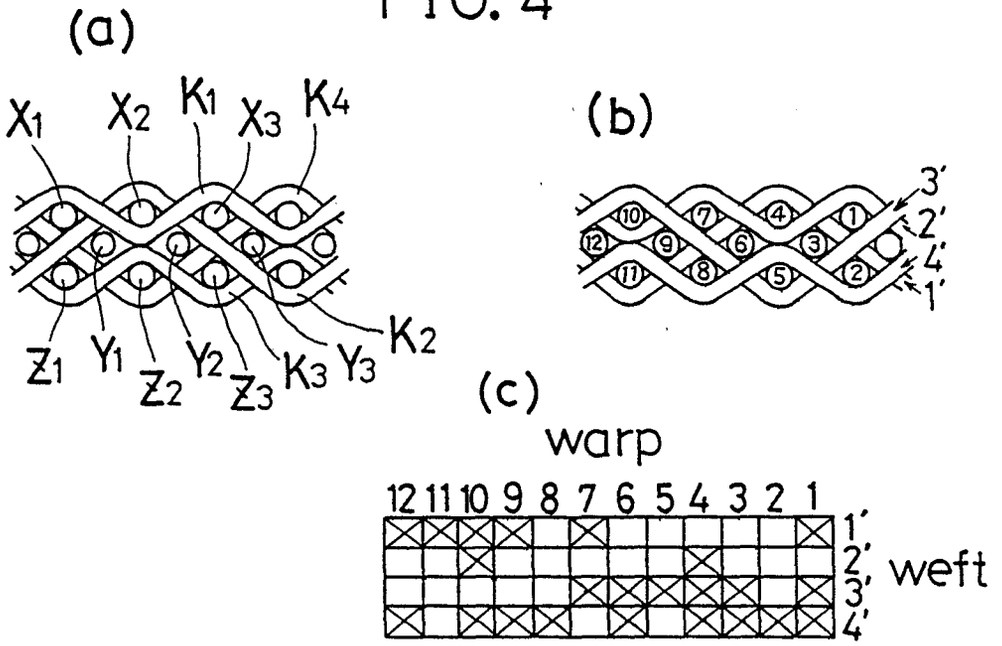

FIG. 5

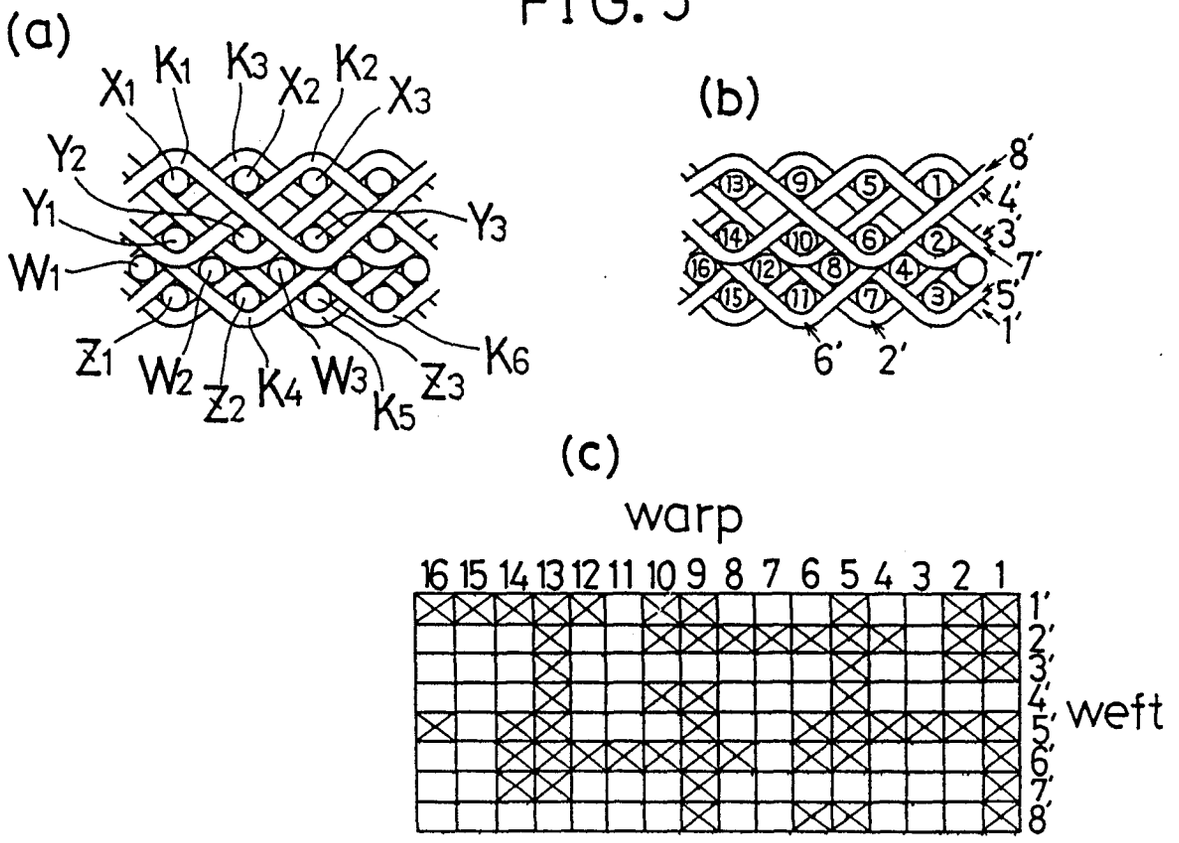

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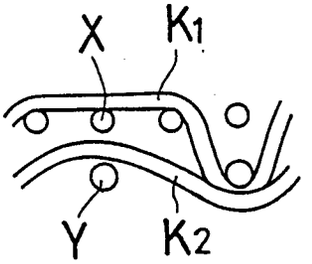
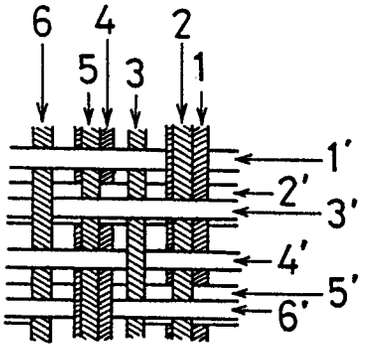
FIG. 6

(a)



(b)



(c)