

Sept. 15, 1964

J. RIEGER ET AL

3,148,710

BELTING FABRIC

Filed Dec. 18, 1961

Fig. 1

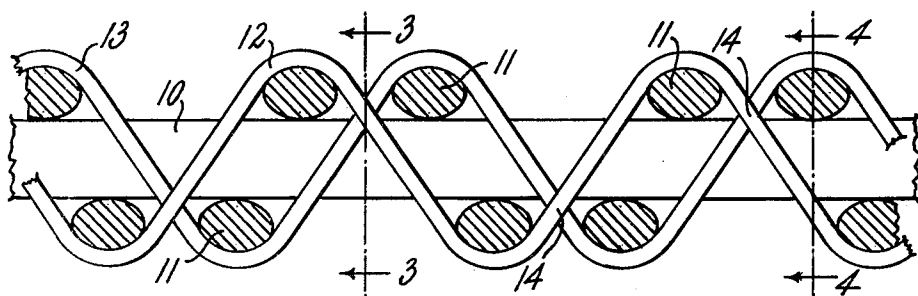
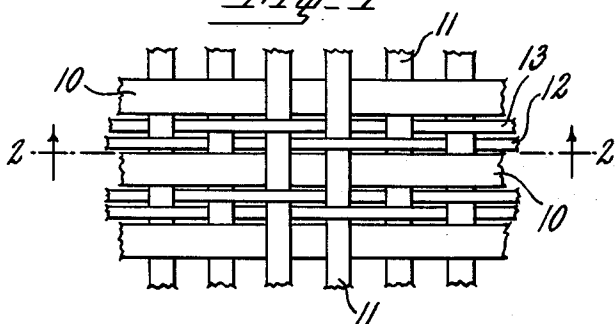


Fig. 2

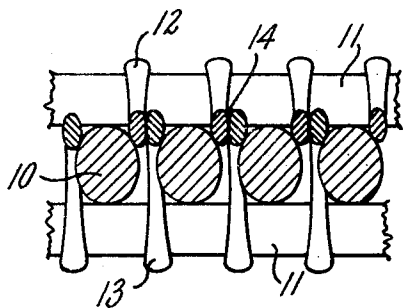


Fig. 3

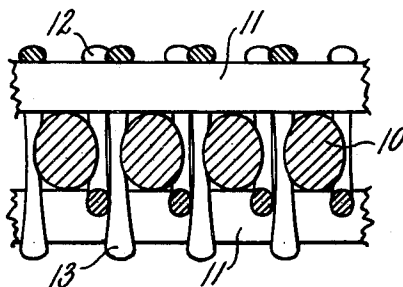


Fig. 4

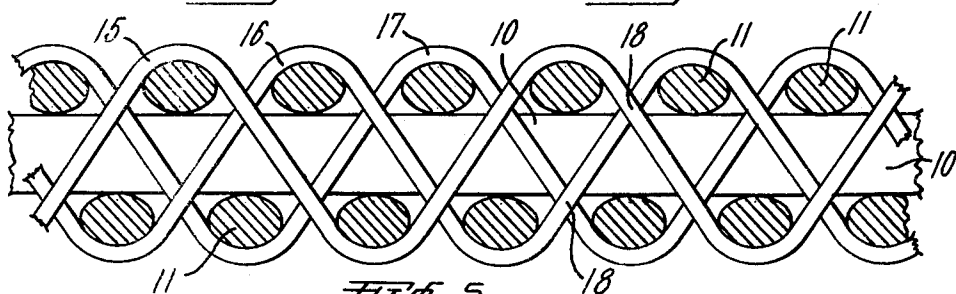


Fig. 5

INVENTORS
JOHN RIEGER, JOHN L. MARCHESE,
DAVID E. COX, CHARLES R. BRADFORD
BY

John O. Tranter

ATTORNEY

1

2

3,148,710

BELTING FABRIC

John Rieger, Teaneck, John L. Marchese, East Paterson, and David E. Cox, Pompton Plains, N.J., and Charles R. Bradford, Decatur, Ga., assignors, by direct and mesne assignments, to United States Rubber Company, New York, N.Y., a corporation of New Jersey

Filed Dec. 18, 1961, Ser. No. 160,118

3 Claims. (Cl. 139-415)

This invention is directed to an improved belting fabric.

More specifically, this invention is directed to improved fabric for use in reinforced belting such as conveyor belts, elevator belts, transmission belts, straps for various uses, and the like.

It is a principal object of this invention to provide a belting fabric having warps, wefts and interlacing binders wherein the warps and wefts of the fabric function relatively independently of each other under normal tensions but become temporarily interlocked or restricted in movement by the action of the binders when the fabric is subjected to abnormal tensions, such as encountered with ripping, tearing, impacting and creasing forces and the forces of mechanical fasteners, the components of the fabric returning with elastic recovery to their unrestricted position upon removal of the abnormal tension or deforming force. Such a belting fabric provides a high degree of flexibility and exhibits highly efficient bilateral mechanical properties under conditions of normal stress, while exhibiting radically different mechanical properties to the extent and in the areas required so as to resist or offset abnormal multilateral stress on either or both the warps and the wefts.

It is a further object of this invention to provide a belting fabric having properties determined primarily by the individual properties of the warp and weft yarns rather than by the weave or weaving technique employed, thereby permitting close uniform design to the exact belt properties required for a particular service. In addition, a belting fabric having such characteristics affords maximum utilization of warp and weft yarn strength while permitting excellent control of belt stretchability and flexibility.

Another object of this invention is to provide a belt carcass having maximum strength per unit of weight and cross-sectional area. This permits the use of smaller diameter pulleys, higher belt speeds and lower belt horsepower requirements.

It is also an object of this invention to provide a belting fabric construction which permits a wide range of finished belt properties due to the many combinations of warp and weft yarns which function independent of each other.

A further object of this invention is to provide a belting fabric wherein the warps and wefts are protected against impact damage and wherein protection is afforded to the warps from external influences. In addition the belting fabric construction of this invention results in minimum internal abrasion between the warps and the wefts.

Another object of this invention is to allow the construction of a belt having a single ply fabric carcass thereby avoiding the danger of ply delamination or separation and obtaining the improved operating performance inherent in a belt having the load carrying member positioned on the central axis. The use of a single ply fabric carcass is made possible by the positioning of the binders which give the fabric the compactness and necessary body for a belt carcass.

Another object of this invention is to provide a belting fabric having maximum fastener holding strength in a minimum thickness.

An additional object of this invention is to provide a belting fabric having improved flexibility through the arrangement of the warps and wefts which minimizes the amount of warp stress that is transferred to the wefts and thereby permits the use of smaller than usual pulleys without damage to the belt. The same considerations permit improved troughing characteristics.

The construction of the belting fabric also permits better yarn tension control during manufacture of the fabric which results in a belt having greater uniformity under service stresses. The belting fabric of this invention also possesses the tear and rip resistance inherent in straight laid yarn fabrics, while at the same time possessing resistance to puncture.

The manner in which the invention accomplishes the foregoing objects, as well as additional objects and advantages, will be apparent from the following detailed description, which is intended to be read with reference to the accompanying drawings, wherein:

FIGURE 1 is a plan view of a belting fabric constructed according to this invention illustrating the fabric components in an expanded position;

FIGURE 2 is a cross-sectional view taken on line 2-2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken on line 3-3 of FIGURE 2;

FIGURE 4 is a cross-sectional view taken on line 4-4 of FIGURE 2; and

FIGURE 5 is a cross-sectional view similar to FIGURE 2 illustrating a modification in the belting fabric construction.

Briefly, the belting fabric of this invention is made up of a plurality of substantially uncrimped parallel warps, a plurality of substantially uncrimped parallel wefts positioned above and below the warps and transverse thereto, the wefts above and below the warps being in non-opposition in the fabric, at least two binders positioned between each of the adjacent warps and interlacing the wefts above and below the warps in alternating sequence with at least one of the binders between each of the adjacent warps interlacing wefts other than those interlaced by another binder between the same adjacent warps, the intersections of the binders between each of the adjacent warps being located alternately above and below the centerline of the warps, the space between said adjacent warps being greater than the compressed diameter of the individual binders between the adjacent warps and less than twice the compressed diameter of said individual binders between the adjacent warps, the tension of the binders in the fabric holding said binder intersections in firm contact with said adjacent warps and being of such magnitude that an increase in said binder tension produced by the extension of the fabric in the direction of the warps beyond the extension produced by the normal working tension will introduce a mutual embedding and crimping of said warps and said wefts and a mutual embedding and crimping of said warps and said binder intersections, the binders in the fabric having a modulus at least as great as the modulus of the warps in the fabric.

With reference to the drawings, the belting fabric has a plurality of parallel warps 10 and a plurality of parallel wefts 11 transversely positioned above and below the warps 10. The warps and wefts are substantially uncrimped in the fabric under normal tensions, that is, they are straight laid with less than 5% crimp. The fact that the warps and wefts are substantially uncrimped and can functionally relatively independently of each other under normal tensions results in a fabric having properties which are determined primarily by the individual properties of the weft and warp yarns. This enables close uniform design to the required belt properties. Also, the absence

of substantial crimp allows maximum utilization of the warp and weft yarn tensile strength, provides maximum strength per unit of weight and cross-sectional area, and permits excellent control of the stretch properties of the belting fabric. Variations in binder tension can be employed as a means of controlling the flexibility and rigidity of the belting fabric. As the warps and wefts function relatively independently under normal tensions, the many possible combinations and variations in warp and weft yarns makes possible the fabrication of belts having a wide range of properties.

As shown in FIGURE 2, the wefts 11 above and below the warps 10 are located in alternating pairs in the fabric so as to be in non-opposition. This reduces the tendency for the warp yarns to become damaged when the fabric is subjected to a crushing blow as would probably result if the wefts above and below the warps were located in direct opposition. In addition, this construction provides a space directly opposite each weft which becomes filled with the elastomeric material of the belt. This provides an impact absorbing elastomeric cushion opposite each weft which further reduces the danger of crushing the fabric yarns, especially the weft yarns. Under supported crushing impact, alternate transverse areas of maximum carcass density are depressed into the opposite elastomeric-filled spaces to cushion the shock.

As shown in FIGURES 1-4, two binders 12, 13 are provided between each of the adjacent warps 10. The binders 12, 13 interlace the wefts 11 above and below the warps 10 in alternating sequence with one of the binders interlacing wefts other than those interlaced by the other binder between the same adjacent warps. The individual wefts need not necessarily be interlaced by binders between each pair of adjacent warps but may be interlaced by binders between every second, or third, et. seq. pair of adjacent warps. The binders, in conjunction with the wefts, protect the warps from external influences. As the adjacent warps and wefts do not cross each other in their individual planes, the internal abrasion or chafing is reduced to a minimum.

Although it is preferred to use synthetic fibers such as nylon, rayon, Dacron, and Fortisan for the warps, wefts and binders, natural fibers such as cotton, hemp, linen and jute may also be employed. Wire strands or glass fiber may also be employed for the fabric components.

The binder intersections 14 between adjacent warps are located alternately above and below the centerline of the warps 10, as shown in FIGURES 2 and 3. The space between the adjacent warps is greater than the compressed diameter of the individual binders between the adjacent warps and less than twice the compressed diameter of the individual binders between the adjacent warps. By compressed diameter is meant the diameter of a yarn in the fabric at a given location. This construction insures that the binder intersections cannot be forced between the adjacent warps, while the space between the adjacent warps is sufficient to allow an individual binder to pass therebetween. The tension on the binders in the fabric is such that the binder intersections are held in firm contact with the adjacent warps. The pressure exerted by the binders and by the binder intersections compact the belting fabric to give it the necessary body for a belt carcass. This factor enables a belt carcass to be made from a single ply of the belting fabric of this invention. Although a belt carcass can be formed from a plurality of separate or interlaced plies of such belting fabric, it is preferred to employ a carcass having a relatively few number of fabric plies as this reduces the possibility of ply separation or delamination and results in the improved performance inherent in a belt having the load carrying member positioned on the central axis. For the above reasons, the most preferred belt construction is one having a single ply carcass.

In order to retain the warps and wefts in a substan-

tially uncrimped condition and to insure firm contact of the binder intersections with the adjacent warps, the tension on the binders is of such magnitude that an increase in binder tension produced by the extension of the fabric in the direction of the warps beyond the extension produced by the normal working tension will introduce a mutual embedding and crimping of said warps and said wefts. As the warps and wefts are in a substantially uncrimped condition, a minimum amount of warp stress is transferred to the wefts under normal tensions thereby improving the belt flexibility and improving troughing characteristics. The improved belt flexibility allows the use of smaller diameter pulleys without damage to the belt.

It is also imperative that the stretch modulus of elasticity of the binders in the fabric be at least as great as the stretch modulus of elasticity of the warps in the fabric. "In other words, the stretch resistance of the binders must be equal to or greater than the stretch resistance of the warps in the fabric." The belting fabric of this invention possesses the unique characteristic of having warps and wefts which function relatively independent of each other under normal working tensions but become interlocked or restricted in movement by the action of the interlacing binders when the fabric is subjected to abnormal working tensions, such as encountered with ripping, tearing, impacting, puncture and creasing forces and the forces of mechanical fasteners. It should be noted that the belting fabric retains flexibility in the transverse direction even under abnormal tensions. The application of abnormal forces tends to displace the components of the fabric which induces a mutual embedding and crimping of each such component resulting in a mutually locked structure to offset the deforming force. The induced locking in the warps and wefts and in the warps and binder intersections resists further displacement of such fabric components. Concurrently, the angle of the binder with the axis of the belt is reduced thereby increasing the contribution of the binder to warp strength. This is particularly significant when considering mechanical fastener holding strength.

With reference to the drawings, it will be seen that an impacting force on an unsupported belt section, a longitudinal or transverse ripping or tearing force, or a load force tending to pull out the bolts, rivets or hooks of a mechanical fastener or elevator bucket, elongating either the warps 10 or the wefts 11 abnormally, brings the binders 12, 13 into action to force the binder intersections 14 as wedges into the space between adjacent warps to unite or lock the warps (see FIGURE 3). The binders 12, 13 also pull the wefts 11 into the spaces between the adjacent warps 10 thereby inducing temporary embedding and crimping into both the wefts and the warps and locking the wefts in position (see FIGURE 4). The opposing and locking scissor action of the binders on the wefts prevents displacement of the wefts relative to the warps. In addition, the normal binder angle with the longitudinal axis of the belt is reduced to bring a higher percentage of binder strength into active resistance. In summary, the belting fabric of this invention retains a high degree of flexibility while exhibiting highly efficient bilateral mechanical properties under conditions of normal stress and radically different mechanical properties to the extent and in the areas required so as to resist abnormal multilateral stress.

Due to the inherent stability of its balanced construction, the belting fabric components will return with elastic recovery to their unrestricted positions upon removal of the abnormal stress or deforming force.

A belting fabric constructed in accordance with this invention provides maximum fastener holding strength in a minimum thickness. The efficiency of a mechanical splice is dependent on the strength and interlocking of the wefts and warps in any fabric. In this invention, the locking action of the binders provide the wefts with

5

excellent holding strength. An additional feature is the compression of the fabric components by the mechanical fastener which induces locking thereby increasing the anchorage of the wefts, whereas in an interwoven structure such action would reduce the crimp and accordingly the anchorage of the wefts. Likewise, the fact that the warps and wefts are straight laid rather than interwoven restrains the tendency of a local rip or tear from spreading due to the inherent rip-stop characteristics of strong straight laid yarns combined with the locking action of the binders.

The fabric illustrated in cross-section in FIGURE 5 represents a modification wherein the wefts 11 are positioned above and below the warps 10 in alternating sequence with three binders 15, 16 and 17 between each pair of adjacent warps. Each binder between a pair of adjacent warps interlaces wefts other than those interlaced by the other binders between the same adjacent warps. The resulting binder intersections 18 are located alternately above and below the centerline of the warps in a manner similar to the structure of the fabric illustrated in FIGURES 1-4. The greater number of binders between adjacent warps results in a greater binder contribution to belt strength and better locking of the wefts to increase the mechanical fastener holding strength.

As the warps and wefts are straight laid, the yarn tension can be more accurately controlled during fabrication to provide a belt having improved uniformity under the stress of service. The wefts are usually laid in a continuous strand with loops at the selvage. The dynamic tension on the wefts during fabrication is the maximum that the loom will support while maintaining proper operation of the shuttle.

The belting fabric is usually not employed as a belt per se but is first impregnated and covered with an elastomeric material. The elastomeric covering layers are usually adhered to one or both sides of the fabric. The edges of the belting fabric may also be covered with the same elastomeric material. Suitable elastomeric materials include natural rubber, synthetic rubbers such as polyurethane rubbers, styrene-butadiene rubbers, butyl rubber, acrylonitrile-butadiene rubbers, etc., and plastics, such as flexible polyvinyl chloride. Prior to adhering the elastomeric covering layers, the belting fabric is usually processed for adhesion. Suitable adhesion processes include (1) resorcinol-formaldehyde latex adhesive treatment on greige fabric followed by a subsequent friction and skim or a subsequent bank coat on a calender; (2) resorcinol-formaldehyde latex adhesive treatment on greige fabric followed by treatment with a rubber cement of a solvent type and a subsequent skim or bank coat on a calender; and (3) isocyanate latex adhesive treatment followed by a subsequent skim or bank coat on a calender.

A typical natural rubber cover formulation is as follows:

Ingredient:	Parts by weight
High modulus crepe	100.0
Light process oil	2.7
Stearic acid	1.0
Zinc oxide	5.0
Pine tar	1.5
Diphenylamine antioxidant	1.5
Carbon black	40.0
Wax	0.5
Phthalic anhydride	0.3
Benzothiazyl disulfide	1.5
Sulfur	3.0
	157.0

A belt covered with natural rubber and having a $\frac{1}{8}$ " thick top cover and a $\frac{1}{16}$ " thick bottom cover is typically cured at 280° F. in a flat press under a pressure of between 150 p.s.i. and 300 p.s.i. for a period of 30 minutes.

6

The following is an example of a conveyor belting fabric constructed according to this invention:

Weight, oz./sq. yd.	65.0.
Warp:	
Count, ends/inch	16.0.
Yarn, ply	1680 denier/2/3 nylon.
Twist, turns/inch	0.5 Z/2.5 S 1.5 Z.
Crimp, percent	2.5.
Yarn tensile, lbs.	158.0.
Elongation at break, percent	18.0.
Binder:	
Count, ends/inch	32.0.
Yarn, ply	1680 denier/2 nylon.
Twist, turns/inch	0.5 Z/2.5 S.
Crimp, percent	60.0.
Yarn tensile, lbs.	58.0.
Elongation at break, percent	16.0.
Weft:	
Count, picks/inch	16.0.
Yarn, ply	1680 denier/6 nylon.
Twist, turns/inch	0.5 Z/1.5 S.
Crimp, percent	2.0.
Yarn tensile, lbs.	158.0.
Elongation at break, percent	18.0.
Average tension, lbs./inch of width:	
Warp	63.2.
Binder	80.5.

An additional example of a conveyor belting fabric is as follows:

Weight, oz./sq. yd.	57.0.
Warp:	
Count, ends/inch	16.0.
Yarn, ply	1680 denier/2/3 nylon.
Twist, turns/inch	0.5 Z/2.5 S/ 1.5 Z.
Crimp, percent	2.5.
Fabric tensile, lbs.	2800.
Elongation at break, percent	18.0.
Binder:	
Count, ends/inch	32.0.
Yarn, ply	1100 denier/3 Dacron.
Twist, turns/inch	2.5 S.
Crimp, percent	50.0.
Weft:	
Count, picks/inch	16.0.
Yarn, ply	1680 denier/4 nylon.
Twist, turns/inch	0.5 Z/1.5 S.
Crimp, percent	2.0.
Fabric tensile, lbs.	1700.
Elongation at break, percent	16.0.
Average tension, lbs./inch of width:	
Warp	63.2.
Binder	80.5.
Gauge, inches	0.135.

While the preferred form of this invention has been described herein, it will be understood that changes in the details thereof may be made without departing from the spirit of this invention, and it is intended to cover all those changes which come within the scope of the appended claims.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. A belting fabric comprising a plurality of substan-

7

tially uncrimped parallel warps, a plurality of substantially uncrimped parallel wefts positioned above and below said warps and transverse thereto, the wefts above said warps and the wefts below said warps being in non-opposition in the fabric, at least two binders positioned between adjacent warps and interlacing the wefts above and below said warps in alternating sequence with at least one of the binders between each of the adjacent warps interlacing wefts other than those interlaced by another binder between the same adjacent warps, the intersections of the binders between each of the adjacent warps being located alternately above and below the centerline of said warps, the space between said adjacent warps being greater than the compressed diameter of the individual binders between the adjacent warps and less than twice the compressed diameter of said individual binders between the adjacent warps, the tension of the binders in the fabric holding said binder intersections in firm contact with said adjacent warps and being of such magnitude that an increase in said binder tension produced by the extension of the fabric in the direction of the warps beyond the extension produced by the normal working tension will introduce a mutual embedding and crimping of said warps and said wefts and a mutual embedding and crimping of said warps and said binder intersections, said binders in the fabric having a stretch modulus of elasticity at least as great as the stretch modulus of elasticity of said warps in the fabric.

2. A belting fabric comprising a plurality of substantially uncrimped, parallel, planar warps, a plurality of substantially uncrimped parallel wefts positioned in the fabric in pairs alternately above and below said warps and at right angles thereto, the pairs of wefts above said warps and the pairs of wefts below said warps being in non-opposition in the fabric, two binders positioned between each of the adjacent warps and interlacing the wefts above and below said warps in alternating sequence with one of the binders between each of the adjacent warps interlacing wefts other than those interlaced by the other binder between the same adjacent warps, the intersections of the binders between each of the adjacent warps being located alternately above and below the centerline of said warps, the space between said adjacent warps being greater than the compressed diameter of the individual binders between the adjacent warps and less than twice the compressed diameter of said individual binders between the adjacent warps, the tension of the binders in the fabric holding said binder intersections in firm contact with said adjacent warps and being of such magnitude that an increase in said binder tension produced by the extension of the fabric in the direction of the warps

8

beyond the extension produced by the normal working tension will introduce a mutual embedding and crimping of said warps and said wefts and a mutual embedding and crimping of said warps and said binder intersections, said binders in the fabric having a stretch modulus of elasticity at least as great as the stretch modulus of elasticity of said warps in the fabric.

3. A belting fabric comprising a plurality of substantially uncrimped, parallel, planar warps, a plurality of substantially uncrimped parallel wefts positioned above and below said warps in alternating sequence and at right angles thereto, the wefts above said warps and the wefts below said warps being in non-opposition in the fabric, three binders positioned between each of the adjacent warps and interlacing the wefts above and below said warps in alternating sequence with each of the binders between each of the adjacent warps interlacing wefts other than those interlaced by the other binders between the same adjacent warps, the intersections of the binders between each of the adjacent warps being located alternately above and below the centerline of said warps, the space between said adjacent warps being greater than the compressed diameter of the individual binders between the adjacent warps and less than twice the compressed diameter of said individual binders between the adjacent warps, the tension of the binders in the fabric holding said binder intersections in firm contact with said adjacent warps and being of such magnitude that an increase in said binder tension produced by the extension of the fabric in the direction of the warps beyond the extension produced by the normal working tension will introduce a mutual embedding and crimping of said warps and said wefts and a mutual embedding and crimping of said warps and said binder intersections, said binders in the fabric having a stretch modulus of elasticity at least as great as the stretch modulus of elasticity of said warps in the fabric.

References Cited in the file of this patent

UNITED STATES PATENTS

421,246	Clouth	Feb. 11, 1890
1,433,467	Manley	Oct. 24, 1922
1,879,243	Hoffacker	Sept. 27, 1932
2,270,154	Whittier	Jan. 13, 1942
2,332,393	Neville	Oct. 19, 1943
2,367,438	Santos	Jan. 16, 1945
3,002,536	Lord et al.	Oct. 3, 1961

FOREIGN PATENTS

857,872	France	Apr. 29, 1940
848,005	Great Britain	Sept. 14, 1960