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FOURDRINIER CLOTH

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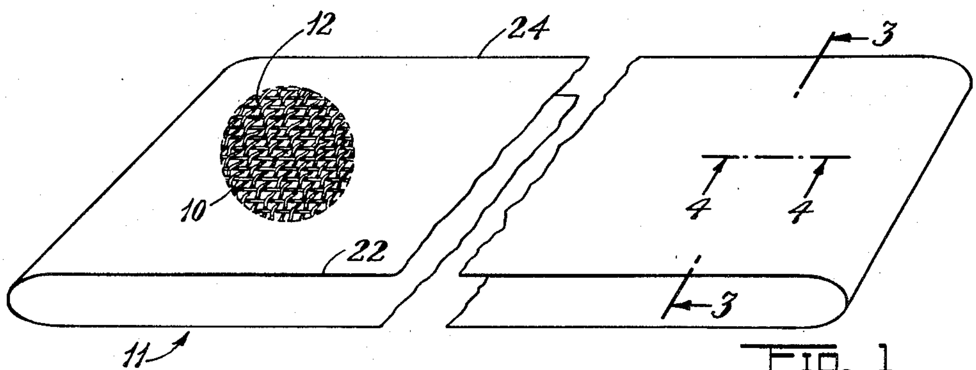

FIG. 1

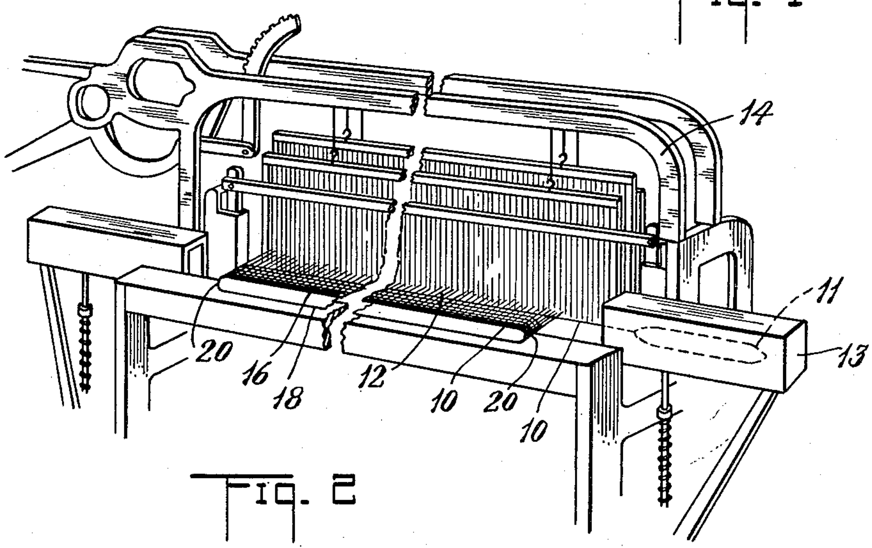

FIG. 2

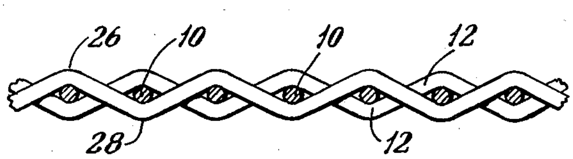

FIG. 3

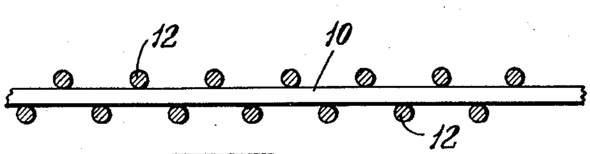

FIG. 4

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FOURDRINIER CLOTH

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12 Claims. (Cl. 139—383)

The present invention relates to Fourdrinier "wires" and in particular to such "wires" made wholly or in part of synthetic resinous materials instead of the metal heretofore commonly used. In view of the inaptness of the word "wire," in this particular instance, the subject of the present invention will be referred to hereinbelow as Fourdrinier cloth.

The Fourdrinier cloth of the present invention may comprise warp yarns and weft yarns woven into any desired or suitable pattern in which said warps or wefts or both are made of synthetic resinous material having high tensile strength and suitable resistance to abrasion, fatigue due to flexing, and the like, whether wet or dry. Nylon, a polyamide fiber, is particularly suitable. Other suitable materials are polyesters such as Dacron or acrylic fibers such as Orlon, dynel and Acrilan or copolymers such as saran. Similar materials offered by various manufacturers under different trade names may be used. The warps and wefts may be of the same or different construction and may be in the form of multifilament yarns or they may be yarns made up of suitable strands or plies which are in turn formed from staple fiber. As will be more fully discussed hereinbelow, certain materials and certain combinations of different materials as well as certain constructons or combinations of constructions of the warps and wefts offer specific advantages.

While it is well known to make cloth for general application from synthetic materials or combinations thereof, and while it is known to make insect screening from monofilaments of synthetic resinous materials, it will be recognized that for various reasons such cloths or such screens do not lend themselves for use in the place of a metal wire screen on a Fourdrinier machine. For instance, there are no known techniques for joining the ends of such synthetic cloth or wire to form an endless belt having uniform porosity in all areas including the area in which the joint is formed. The present invention provides a Fourdrinier cloth which is woven in endless form from suitable synthetic resinous material and which therefore has the necessary uniformity of porosity throughout its length. Also, the warps and wefts may be constructed as taught in this specification to produce a Fourdrinier cloth having excellent dimensional stability and wear resistance under the conditions to which it is subjected in normal use on a Fourdrinier machine.

The endless Fourdrinier cloth of the present invention presents a number of unexpected advantages over the metal Fourdrinier wires heretofore used. The Fourdrinier cloths of the present invention are completely flexible in all directions and are very easy to install on the papermaking machine. They are not subject to damage as a result of creasing or wrinkling during shipment or installation. In contrast with this the metal wires heretofore used have required exceptional and expensive care in packing, shipment and installation. Also, the join in metal wires is frequently a source of failure by rupture and in many instances, the area of the join differs somewhat in porosity from the remaining areas of the metal wires.

The Fourdrinier cloths of the present invention are woven endless and therefore have no joints to fail or to offer uneven porosity. The materials from which the Fourdrinier cloths of the present invention are made have substantially higher elongation before permanent deformation than the metal wire ordinarily used. Accordingly, the Fourdrinier cloths of the present invention resist shock loading such as that brought about by wads of paper stock or foreign materials which so frequently wreck a metal wire when dropped upon the wire or caught between the wire and a roll or suction box. Particles removed from the Fourdrinier cloths of the present invention are not abrasive as in the case of metal particles removed by wear from metal Fourdrinier wires. Accordingly, the use of the present invention will result in a longer life for various machine parts, such as suction boxes.

It is an object of the present invention to provide an endless Fourdrinier cloth made of synthetic resinous material. Other and further objects of the present invention will become apparent from a reading of the appended specification in which preferred but not necessarily the only forms of the invention will be described in detail, taken in connection with the drawings accompanying and forming a part of this specification.

In the drawings:

Fig. 1 is a perspective view of a Fourdrinier cloth embodying the present invention;

Fig. 2 is a somewhat diagrammatic representation of a loom arranged for weaving of a Fourdrinier cloth in accordance with this invention;

Fig. 3 is a section along the line 3—3 in Fig. 1; and

Fig. 4 is a section along the line 4—4 in Fig. 1.

Referring now to the drawings, there is illustrated in Fig. 1 an endless Fourdrinier cloth made up of interwoven yarns 10 and 12 extending respectively lengthwise and transversely of the width of the endless belt.

Referring now to Fig. 2, the material from which the endless belt shown in Fig. 1 is made is shown emerging from a loom 14. In said Fig. 2 it will be observed that yarns 10 extend transversely of the loom and thus have been woven into the cloth as wefts or fillers, while the yarns 12 extend lengthwise of the loom and thus have been woven as warps. The length of cloth emerging from the loom 14 is tubular and any well known arrangement for the weaving of tubular fabrics may be employed. For example, the warps 12 may be arranged in harnesses to form two sheds for the upper and lower portions 16 and 18, respectively, and in special harnesses or guides to form the continuous end zones 20. The wefts 10 may be supplied by one or more shuttles. In the event that a single shuttle is used, the weft 10 is projected through one of the sheds and is returned, without cutting, through the other shed in the next heat of the loom, thus forming a continuous helix of the weft yarn. If a plurality of shuttles are used, they will follow one another in sequence without cutting at either end of the loom whereby the wefts 10 are formed into a plurality of continuous parallel helices. In either event each yarn which is woven as a weft forms a helix which is continuous for a large number of beats of the loom, limited only by the capacity of the bobbins used in the shuttles. When a bobbin is exhausted and must be replaced, the ends of the old and new weft yarns for that particular shuttle will be overlapped as is customary in the weaving of endless tubular fabrics. In Fig. 2, a single shuttle 11 is shown resting in the shuttle box 13 at the drive end of the loom.

The endless belt shown in Fig. 1 is cut to suitable width by cutting the fabric in a direction parallel with the wefts 10, thus transversely severing the warps 12. As shown in Fig. 1, the warps 12 extend transversely of the width of the belt and the weft or wefts 10 extend in substantially continuous form throughout the length of the belt. It will be apparent that each continuous helical weft **10** will be severed at one place along each of the edges of the belt and that the severed ends of the warps **12** will form raw cut edges **22** and **24**. It will be understood that such edges may be reinforced or bound in any suitable fashion. For example, they may be stitched or immersed in a settable adhesive or binding material such as a plastic or rubber or synthetic rubber or fused by heat from a flame or heated surface to insure stability along the edges **22** and **24**.

It is a normal incident of weaving in a conventional loom that the warps assume a generally curved shape whereas the wefts remain substantially straight. In Figs. 3 and 4 a plain weave is shown for illustrative purposes and in such a weave the warps **12** follow a curved path to lie respectively above and below adjacent wefts **10**. The warps **12** are thus formed with knuckles **26** and **28** which become the wearing surface of the cloth. The Fourdrinier wire in a paper making machine is conducted over guide rolls, table rollers, suction boxes, suction presses and the like, and it will be apparent that the knuckles **26** or **28** receive the maximum amount of abrasion. In a conventional metal wire which is woven to indefinite length and is butt-joined to form an endless belt, the warps extend lengthwise of the wire and are called upon not only to resist tension but also are subjected to abrasive wear at the knuckles which, of course, progressively reduces the tensile strength to a point of failure. It is particular advantage of the present invention that the warps extend crosswise of the cloth and wear upon the knuckles does not progressively reduce the tensile strength lengthwise of the belt. In specific forms of the present invention the warps may be made of a material or construction chosen for resistance to abrasive wear while the wefts may be made of a different material or construction chosen for tensile strength.

Except in the specific forms just mentioned, the Fourdrinier cloth in accordance with the present invention may be woven with warps and wefts of any of a wide variety of materials, combinations of materials or constructions. Thus multifilament yarns of synthetic materials of the long-chain polymer or addition polymer types such as nylon, Orlon, Dacron, saran or similar materials or blends thereof may be used for both warp and weft. Similarly, yarns of such synthetic materials or blends constructed in a manner similar to worsted, woolen or cotton yarns from plain, curled or crinkled staple fibers may be used for warp and weft. A specifically preferable form which offers the advantages of good abrasive resistance and good tensile strength lengthwise of the cloth may be made with multifilament yarns as wefts and staple fiber yarns as warps. The multifilament yarns are superior in tensile strength to staple fiber yarns while the latter have better abrasion resistance. Also in some cases, monofilaments may be used as warps inasmuch as monofilaments have good abrasion resistance.

It might be expected that monofilaments would be suitable for use as both warp and weft in the present invention. Also, monofilaments of synthetic materials of the type herein discussed have been used for both warp and weft in insect screening which has found some success as a substitute for the metal wire insect screening in common use. However, for the purposes of the present invention, fabrics having synthetic monofilaments for both warp and weft are not desirable or successful and a product such as the so-called "plastic" insect screening does not lend itself to the present invention wherein Fourdrinier cloths are woven in endless form. In the art of manufacture of metal Fourdrinier wires, many special techniques have been developed for the production of smooth paper-supporting surfaces and the establishment of desirable and uniform drainage rates and the usual metal Fourdrinier wire thus bears very little resemblance to metal insect screening. The present invention, which makes use of multifilaments or yarns constructed from

staple fiber, provides Fourdrinier cloths in endless form having unusually smooth paper-supporting surfaces and unusually desirable drainage characteristics and which may be woven on looms and with techniques normally associated with the production of textiles. Synthetic monofilaments, like wire, must be relatively coarse to provide the tensile strength necessary for use on a Fourdrinier machine and they are therefore not desirable for use as wefts in the present invention. Furthermore, while monofilaments may be used as warps in the present invention, they present severe difficulties in connection with the weft which must be wound on bobbins or the like for use in the shuttles. Preferably the Fourdrinier cloth of the present invention is manufactured from yarns or multifilaments which may be handled with recognized facility in ordinary textile looms. Furthermore, the tensile strength necessary for the end use may be attained with yarns or multifilaments which would be regarded as substantially finer than the coarse wires normally used in metallic Fourdrinier wires. Thus, by proper selection of the weight of the synthetic staple fiber yarns or synthetic multifilaments and of the fineness of the weave, Fourdrinier cloths of adequate strength having remarkably long life in use can be produced with drainage rates which are uniquely desirable. With the relatively fine gage products which may be made in accordance with this invention, paper of excellent formation and substantial freedom from "wire marking" may be produced.

Many of the materials contemplated for use in the present invention do not exhibit the characteristic of taking a permanent set under impact of the reed when weaving occurs at normal room temperature. It will be appreciated that the curved shape imparted to warps of metallic wire become relatively permanent and metallic Fourdrinier wires have desirable dimensional stability. With many of the synthetic materials herein contemplated the warps tend constantly to assume a straightened condition and under such circumstances the finished cloth is likely to be sleazy. To avoid the disadvantages which might flow from such sleaziness, it is preferred, in accordance with the present invention, to form permanent bonds at each intersection of the warp and weft. This may be achieved by treatment of the finished fabric with a suitable bonding or adhesive material such as a settable resin. In the case of Fourdrinier cloths made in accordance with the present invention as endless belts in which both warp and weft are yarns of synthetic resinous material, the finished belt may be immersed, either before or after cutting to suitable width, in settable resinous material which is thereafter set to form bonds at each crossing. The bonds thus formed not only will stabilize the body of the fabric but will serve to reduce likelihood of raveling of the edges. Since multifilament or staple fiber yarns or combinations thereof are used as warp and weft in several forms of the present invention, the settable resinous material is preferably so chosen as to impregnate the interstices of the yarn construction as well as to form bonds in the crossings.

Formation of bonds at the crossings may also be achieved by utilizing the thermoplastic characteristic which is common to all of the fibers useful in this invention. Since some of the fibers are more sensitive to heat than others, it may be preferable to blend a lower-melting-point fiber with a higher-melting-point fiber and treat the finished fabric at such temperature as to make only the lower-melting-point fibers sufficiently tacky to form the desired bonds at the crossings. In either event, the woven fabric is subjected to treatment such as calendering at a sufficiently elevated temperature and pressure or to heat in an oven while the fabric is maintained under tension to form the bonds which will become permanent upon cooling of the fabric.

In the case of certain materials, it is desirable to use those forms of the materials which exhibit maximum abrasive resistance or tensile strength as may be desired.

For example, it is customary to stretch nylon filaments at an elevated temperature to impart a heat set which gives greater dimensional stability to the finished product. Also heat setting techniques which crinkle, crimp or curl staple fibers of synthetic materials may be availed of to produce yarns having high tensile strength and other characteristics desirable for the present invention.

As a specific example of the present invention, a Fourdrinier cloth may be woven on a conventional fabric weaving loom so arranged as to weave a tube of indefinite length. The warps may comprise nylon multifilament yarns of approximately 630 denier and made up of 102 filaments, while the wefts may comprise nylon multifilament yarns of approximately 420 denier and made up of 68 filaments. The wefts may be supplied by a single shuttle or a plurality of shuttles as desired, but in any event, the yarn forming the weft is woven with the warps in a continuous fashion. The cloth may have a count of 64 warps per inch and 37 wefts per inch. Fourdrinier cloths of appropriate width may be cut from the continuous tube in a direction transverse the warps. The total length of each endless Fourdrinier cloth thus formed is, of course, equal to the periphery of the tube as woven. For example, with a loom adapted to weave fabrics 600 inches wide, the maximum periphery of the woven tube will be approximately 1200 inches which is an adequate length for many paper making and similar machines.

Fourdrinier cloths made in accordance with this first example are then preferably immersed in a heat settable resinous material, for example, a melamine resin in a solution of 20% concentration in water. Thereafter the Fourdrinier cloths are subjected to an elevated temperature sufficient to set the melamine resin thereby to form bonds at the crossings between warp and weft.

The edges of the Fourdrinier cloths made in accordance with this first example may then be reinforced or bound, if so desired, in any well known fashion. For example, the extreme edge portions may be immersed in a heated thermoplastic material such as ethyl cellulose which will set upon cooling to bind the extreme edge portions even more securely than the remaining portions.

The Fourdrinier cloth made in accordance with this first example exhibits excellent tensile strength and dimensional stability.

As a second example of the present invention, multifilaments of Orlon of 400 denier and made up of 160 filaments may be used for the warps, and multifilaments of Orlon of 200 denier and made up of 80 filaments may be used for the wefts. The finished cloth may have a count of 60 warps per inch and 50 wefts per inch. The finished Fourdrinier cloths cut from the tube may be set with resin if so desired, as described above in connection with the first example.

As a third example of the present invention, a multifilament yarn of nylon, Orlon or Dacron may be used for the wefts. The multifilament wefts may be of any desired weight. For example, they may run from 60 denier to 840 denier for any combinations from 41 to 354 individual filaments twisted together in a well known manner. The warps may be yarns of nylon, Orlon, Dacron, or Saran staple fibers spun into yarn formed by either the woolen or worsted systems. The warps, like the wefts, may be of any desired weight. For example, they may run from 100 denier to 840 denier. Preferably the staple fibers are crimped, curled or otherwise treated as is common practice with such fibers to yield a yarn having good tensile strength and abrasion resistance. In the Fourdrinier cloth of this third example the superior abrasive resistance of the spun yarn warps, in which the knuckles are formed, gives greater life to the cloth. The superior tensile strength of the multifilament wefts, which run lengthwise of the finished cloth, gives greater lengthwise stability to the cloth. If the finished cloth is impregnated with a suitable thermosetting resin, as is the preferred practice, the finished cloth exhibits great dimensional stability and wearing ability. Of the various staple fibers which may be used in accordance with this third example, it is preferred to use crimped nylon staple fibers for the construction of the warp yarns.

As a fourth example of the present invention, any of the staple fiber or multifilament yarns of any of the preceding examples may comprise blends of any of the fibers set forth above as suitable for use in this invention. Thus the warp or weft yarns or both may be formed from a blend of staple or multifilament fibers such as 50% Nylon and 50% Orlon.

As a fifth example of the present invention, any of the fabrics set forth in the first four examples may be stabilized by utilizing the thermoplastic characteristic common to all of the disclosed fibers instead of by use of a thermosetting resin. An all Nylon fabric or one which is made from a blend of Nylon and Orlon may be stabilized by heat treatment at about 460° F. for about five seconds. Thus the woven tubular fabric may be passed through calender rolls heated to the desired temperature at which the fibers will become somewhat tacky, without actually melting. The combined effects of heat and pressure will form durable bonds at the crossings. Similar results may be obtained with any of the other fibers or blends thereof by selection of suitable temperatures.

As a sixth example the warps or wefts or both may comprise yarns which are a blend of at least two fibers, one of which will become tacky at a substantially lower temperature than the other fiber. Such a fabric may be stabilized by heat and pressure in calender rolls, as disclosed above, at a temperature such as to render only the lower-melting-point fiber tacky. Also, the fabric may be placed under longitudinal tension, as by passing it around spaced rolls, in an oven where a temperature is maintained which will render only the lower-melting-point fibers tacky. A specifically desirable fabric in accordance with this example may be made with the warp or weft yarns, or both, formed from staple fibers or multifilaments which are blended in the proportion of 70% Dacron and 30% dynel. The woven fabric may be heat treated in calender rolls or flat under tension in an oven at 260° F. for five seconds. Such heat treatment will render the dynel fibers sufficiently tacky to form bonds at the crossings. The Dacron fibers will remain substantially unaffected by the heat treatment although they will be at least partially bonded together when the dynel fibers with which they are blended are rendered tacky.

As a seventh example the weft yarns may be any of those specified above, preferably Nylon multifilament or staple fiber yarns, and the warp yarns may be monofilaments of saran of a diameter of 0.008". The woven tubular fabric may be heat treated at 250° F. for five minutes to render the saran monofilaments sufficiently tacky to adhere to the wefts whereby to form strong bonds at the crossings. The heat treatment may be applied with the endless belt under tension in an oven at 250° F. or in calender rolls. In either case, the crossing bonds will be formed and where the wefts are made of a fiber such as Nylon, which may be heat-set at the 250° F. temperature here involved, the final product will be set in an extremely flat and wrinkle-free condition. Since a Fourdrinier wire in normal use is not likely to be subjected to temperatures above or closely approaching the 250° F. at which the Fourdrinier cloth of the present example was set, the set should be retained throughout a long useful life.

The Fourdrinier cloths of all of the examples herein set forth will have, in greater or less degree, the advantage of being heat-set in flat, wrinkle free condition at a temperature exceeding anything to which they normally will be subjected in use. Thus it has been pointed out that it is preferred to stabilize all of the cloths by forming bonds at the crossings and whether the cloths are impregnated with a heat-setting resin as in some examples, or are stabilized by fusing of the thermoplastic components as in other examples, they will be maintained flat while cooling and will assume a desired heat-set condition.

In certain of the above examples, desirable combinations of weight and count of the warp and weft yarns have been given in specific terms or in terms of ranges. The specific combinations are such as to produce a fabric having a weave of sufficient "openness" to provide drainage characteristics essential to the use of the fabric as a Fourdrinier cloth. The ranges are to be used with appropriate proportioning between weight and count to provide the desired degree of "openness." The selection of any particular combination will be guided by the particular type of paper, board or similar felted fibrous product which is to be formed as well as upon the characteristics, dimensions, speed, etc. of the machine, and other factors similar to the art. Except where otherwise limited in the specification and claims the word "yarn" is used herein in a broad sense and is intended to include monofilament, multifilament and staple fiber constructions.

What is claimed is:

1. A Fourdrinier cloth for papermaking and similar machines, comprising an endless belt of predetermined width formed of interwoven warp and weft yarns in which the warp yarns extend transversely across the width of said belt and assume a curved shape to form knuckles in engaging upper and lower surfaces of the weft yarns, and the weft yarns extend in a substantially uniform direction lengthwise of and around the belt so as to form at least one substantially continuous helix progressing from one edge of the belt to the other, all of said interwoven yarns consisting substantially entirely of synthetic fiber forming materials characterized by their great tensile strength and resistance to abrasion and flexing whether wet or dry.

2. A Fourdrinier cloth as in claim 1 wherein at least each of the yarns extending lengthwise of said belt are multifilament yarns.

3. A Fourdrinier cloth as in claim 1 wherein each yarn extending lengthwise of said belt is a multifilament yarn and each transversely extending yarn is a staple fiber yarn.

4. A Fourdrinier cloth as in claim 1 wherein all of said interwoven yarns consist substantially entirely of one or more synthetic materials selected from the group consisting of multifilaments or staple fibers of polyamide, polyester, acrylic and copolymer fiber forming materials.

5. A Fourdrinier cloth as in claim 4 wherein at least each of the yarns extending lengthwise of said belt are multifilament yarns.

6. A Fourdrinier cloth as in claim 4 wherein each yarn extending lengthwise of said belt is a multifilament yarn and each transversely extending yarn is a staple fiber yarn.

7. A Fourdrinier cloth for paper-making and similar machines, comprising an endless belt of predetermined

width formed from interwoven yarns extending lengthwise and transversely of the width of said belt, each lengthwise extending yarn forming a substantially continuous helix and consisting substantially entirely of one or more synthetic materials selected from the group consisting of multifilaments or staple fibers of polyamide, polyester, acrylic and copolymer fiber forming materials, and all of the transversely extending yarns consisting substantially entirely of one or more synthetic materials selected from the group consisting of monofilaments, multifilaments or staple fibers of the same fiber forming materials.

8. A Fourdrinier cloth as in claim 7 wherein the yarns extending lengthwise of said belt are multifilament yarns and each transversely extending yarn is a monofilament.

9. The method of manufacturing Fourdrinier cloths for paper-making and similar machines comprising weaving a fabric as a continuous tube having warp and weft yarns of synthetic material and with each weft yarn forming a substantially continuous helix extending circumferentially of said tube, selecting the synthetic material for said warp yarns from the group of monofilaments, multifilaments or staple fibers of polyamide, polyester, acrylic and copolymer fiber forming materials, selecting a synthetic material for said weft yarns from the group of multifilaments or staple fibers of the same fiber forming materials, cutting said fabric tube along lines substantially parallel with said wefts to form endless fabric belts in which said wefts extend lengthwise of said belts, and binding said warp and weft yarns together at the crossings.

10. The method set forth in claim 9 wherein said warp and weft yarns are bound at the crossings by applying to said belts an adhesive material and setting said adhesive material while said belts are maintained in flat smooth condition.

11. The method set forth in claim 9 wherein the warp and weft yarns are bound at the crossings by heating said belts to a temperature sufficient to soften at least a portion of the synthetic materials selected for said yarns, and cooling said belts while the same are maintained in flat smooth condition.

12. The method set forth in claim 9 wherein the warp and weft yarns are bound at the crossings by subjecting said belts to pressure between calendar rolls which are heated to a temperature sufficient to soften at least a portion of the synthetic materials selected for said yarns, and cooling said belts while the same are maintained in flat smooth condition.

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