

[54] **WOVEN FOURDRINIER FABRIC**
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 [21] Appl. No.: **417,873**

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[52] U.S. Cl. **139/425 A; 162/DIG. 1**
 [51] Int. Cl. ... **D03d 15/00; D03d 15/02; D21f 1/10**
 [58] Field of Search **139/425 A, 425 R, 420 R, 139/383 A, 408-415; 162/348, 349, DIG. 1; 74/239; 34/95; 245/2, 8; 102/348, 349, DIG. 1**

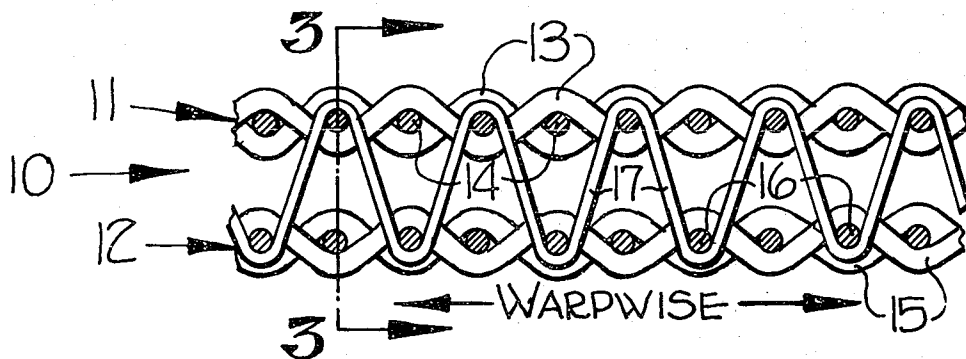
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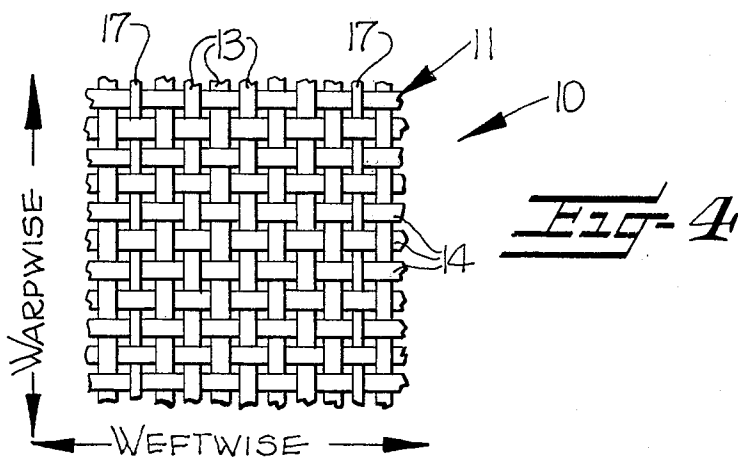
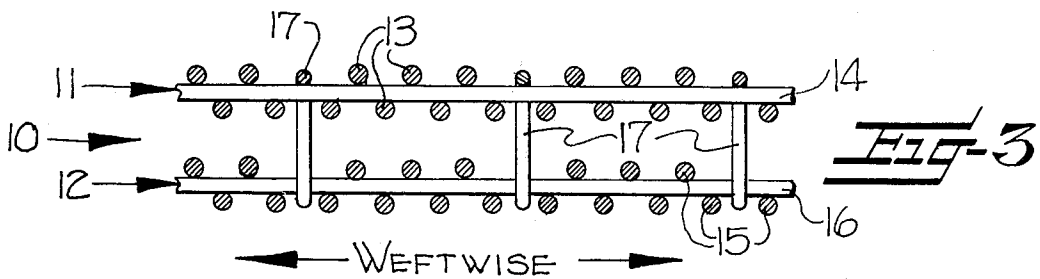
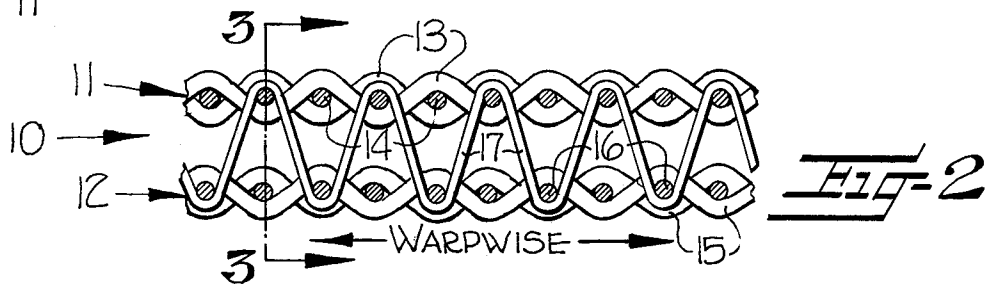
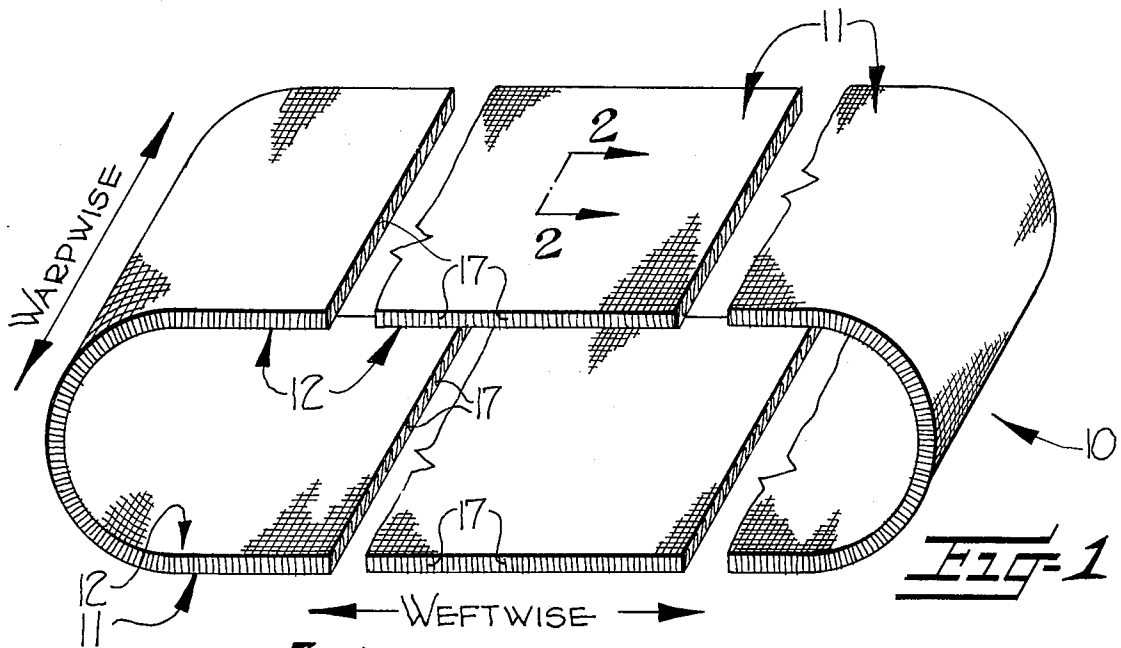
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[57] **ABSTRACT**
 A woven Fourdrinier fabric so constructed that it has a relatively long useful life. The fabric is characterized by having at least two interconnected plies with each ply being of a mesh weave and wherein the size and number of yarns per square inch thereof are such that each ply has at least about 9% open area for permitting drainage therethrough of liquid from a slurry used in the manufacture of paper and the like.

8 Claims, 4 Drawing Figures





WOVEN FOURDRINIER FABRIC

This invention relates to an improved fabric for use in the construction of endless Fourdrinier forming belts employed in the manufacture of paper and comparable fibrous materials.

It is well known in the papermaking industry that paper is produced by flowing a slurry of pulp or cellulosic fibers and/or other paper components mixed with water and/or other liquid onto a moving endless belt commonly known as a Fourdrinier forming belt. Fourdrinier forming belts are necessarily of substantial length and are quite porous so that a major portion of the liquid is removed from the slurry by drainage. After most of the liquid has been removed, the thus formed paper web is transferred to a so-called papermakers' drier felt which conveys the paper web through the nips of heated cylinders to extract the residual moisture from the paper web.

Papermakers' drier felts are generally formed of a very coarse, compactly woven fabric, and the capillary potential of such fabric is relied upon to aid in the removal of moisture from a paper web product being processed thereon. Papermakers' drier felts necessarily have no more than about 2 percent to 3 percent open area throughout the same in order to serve their intended function of supporting and conveying the paper web during the extraction of residual moisture therefrom. Fourdrinier forming belts, on the other hand, are quite distinct from drier felts in that at least the face thereof must be of a fine mesh weave with the mesh thereof being of such size and count as to readily permit drainage of liquid from the slurry, while providing a satisfactory supporting surface for obtaining a paper product of the desired quality. Fourdrinier belts may be woven from metallic, natural and/or synthetic warp and weft yarns or strands, and it is necessary that such belts are of high tensile strength so as to be placed under substantial tension.

Fourdrinier forming belts also must be highly stable; i.e., it is highly desirable that such belts will be subject to very little, if any, stretch or elongation and/or contraction in normal use so that the strands or yarns thereof will not shift excessively relative to each other and thereby unduly restrict, close or elongate the openings or interstices in the belt. However, Fourdrinier forming belts have been of single ply woven construction heretofore, and have thus been so constructed as to have an undesirable relatively short useful life because of the flexing, relatively rapid abrasion and consequent fracture of the surfaces of those portions of the strands of the belt which engage and necessarily creep or slide on the supporting rolls and other supporting surfaces of a papermaking machine. Such portions of the strands in a Fourdrinier forming belt are generally known as "warp knuckles" and/or "shute knuckles." Since Fourdrinier forming belts generally have an overall length of up to about 140 feet, not only are they quite expensive to manufacture, but considerable expense and downtime are involved in replacing an excessively worn or fractured Fourdrinier forming belt with a new one.

It is therefore an object of this invention to provide an improved Fourdrinier forming belt fabric of high dimensional stability and which is so constructed as to have a life in normal use substantially greater than that of any Fourdrinier forming belts known heretofore.

It is a more specific object of this invention to provide an endless Fourdrinier forming belt fabric comprising at least two interconnected layers or plies of woven mesh fabric, namely, an outer or top ply and an inner or bottom ply, and wherein the size and number of warp yarns and weft yarns per square inch of the fabric are such that each ply thereof has at least about 9 percent open area therethrough, at least in the major or "formation" area of the fabric; i.e., the area upon which the slurry is deposited, so that liquid from the slurry, when received on the top ply of the fabric, may readily drain through the fabric, and the bottom ply thus serves as a wearing surface which may be substantially worn away before the top ply is subjected to abrasion by contact with the supporting rolls of a papermaking machine, thereby greatly extending the useful life of the Fourdrinier forming belt fabric.

It is another object of this invention to provide a Fourdrinier forming belt fabric of the type described wherein the warp and weft yarns thereof are of synthetic material.

Some of the objects and advantages of the invention having been stated, others will appear as the description proceeds when taken in connection with the accompanying drawings, in which

FIG. 1 is a partially exploded schematic perspective view of the improved endless Fourdrinier forming belt fabric of this invention;

FIG. 2 is a schematic transverse or warpwise sectional view through a portion of the improved Fourdrinier fabric taken substantially along line 2—2 in FIG. 1;

FIG. 3 is a fragmentary weftwise sectional view taken substantially along line 3—3 in FIG. 2; and

FIG. 4 is an enlarged fragmentary top plan view of a portion of the fabric illustrating the mesh construction thereof.

Referring more specifically to the drawings, the preferred embodiment of the improved Fourdrinier forming belt fabric of the present invention is broadly designated at 10 and comprises an outer or face ply or layer 11 and an inner or backing ply or layer 12 which are arranged in superposed relationship, and both of which are preferably of endless form. The outer and inner plies 11, 12 also may be termed as respective top and bottom plies of the belt fabric, since the plies 11, 12 occupy such position when in use and when passing through the slurry-receiving upper reach of the Fourdrinier forming belt formed thereof.

At least the top or outer ply 11 should be of a relatively fine mesh weave and, in any event, both of the plies 11, 12 should be of a mesh weave having at least 9 percent open area throughout the same, as best shown in FIG. 4, so as to readily permit drainage therethrough of liquid from a slurry used in the manufacture of paper and the like. The outer or top ply 11 is woven of main warp yarns 13 and weft yarns 14, and the inner or bottom ply 12 is woven of main warp yarns 15 and weft yarns 16. Although each of the plies 11, 12 is shown as being in the form of a plain weave, it is to be understood that they may be of any other suitable weave constructions, such as a twill or semi-twill weave, for example.

The outer and inner plies 11, 12 of the Fourdrinier fabric 10 are practically independent of each other. However, the plies 11, 12 are interconnected by a plurality of interlacing binder warp yarns 17 which extend

generally parallel with the main warp yarns 13, 15, and which extend transversely across the Fourdrinier belt fabric 10 (FIG. 1). It is preferred that there are at least twice as many main warp yarns 13, 15 in each respective layer of the fabric 10 as there are binder warp yarns 17. Also, it is preferred that the binder warp yarns 17 are spaced weftwise apart from each other as shown in FIGS. 3 and 4, for example, so that the outer and inner plies 11, 12 may shift or yield relative to each other when the Fourdrinier belt fabric 10 is in use and as successive portions of the belt fabric are moving in engagement with the cylindrical surfaces of supporting rolls of a papermaking machine, thereby reducing the abrasive action to which the inner or bottom ply 12 may be subjected by frictional engagement with such surfaces.

As shown in FIGS. 2 and 3, the plies 11, 12 are spaced apart for purposes of clarity. However, it is to be understood that the two plies actually are held in contact with each other by the binder warp yarns 17. As indicated above, it is preferred that there is a lesser number of binder warp yarns 17 in the Fourdrinier forming belt fabric 10 than there are warp yarns in each ply 11, 12 thereof. As shown in FIGS. 3 and 4, there is one binder warp yarn for every seven main warp yarns in each ply, for example. Also, binder warp yarns 17 may be somewhat smaller than at least the warp and weft yarns 13, 14 of the outer or face ply 11, if desired. As preferred, the binder warp yarns 17 are looped over alternate weft yarns 14 in outer ply 11 and they are looped beneath intervening weft yarns 16 in inner ply 12 of fabric 10.

When the Fourdrinier belt fabric 10 is woven in endless form, as shown in FIG. 1, it is to be noted that the weft yarns 14, 16 in the two plies 11, 12 are continuous and extend longitudinally throughout the upper and lower reaches of the Fourdrinier forming belt fabric and, since the belt fabric 10 is woven in a progressive manner, the weft yarns 14, 16 extend in generally helical form progressing from one edge of the fabric to the other. Of course, the warp yarns 13, 15, 17 of the endless Fourdrinier forming belt fabric extend transversely or across the belt fabric.

It is preferred that the Fourdrinier forming belt fabric 10 of this invention is woven from multifilament synthetic yarns, although it is to be understood that the yarns may be in the form of metal strands, they may be in the form of metal strands coated with a plastic material, they may be in the form of continuous multifilaments or monofilaments, they may be formed from yarns of natural or man-made staple fibers or they may be of any suitable combination of filaments and/or fibers of different types. In the event that metal or plastic-coated metal yarns are present in the belt fabric 10, it is preferred that the top ply 11 thereof is woven of synthetic continuous-filament or staple-fiber yarns, since synthetic yarns are generally less brittle than metal yarns, and synthetic yarns generally provide a more durable and smoother surface for receiving a slurry of pulp and water thereon than is the case with respect to metal yarns.

If plastic coated metal yarns are employed in weaving the fabric 10, it is preferred that they are used to extend in only the widthwise direction of the Fourdrinier belt formed therefrom and with yarns of more pliable synthetic and/or natural textile material extending in the lengthwise direction of the belt. By such an arrange-

ment of the plastic coated metal yarns, they would be subjected to relatively little or no flexing as they passed about rolls and over the edges of suction box tops of a Fourdrinier forming machine.

Further, if synthetic yarns are used, it is preferred that the woven endless belt fabric is heat-set to aid in preventing stretching of the belt, and it is preferred that the yarns are of the continuous filament type since they would normally be of greater tensile strength than staple-fiber synthetic yarns. Typical synthetic yarns which may be used in the manufacture of the belt fabric may be formed from nylon, polyester, acrylic, polypropylene or other synthetic strand materials. As shown, all of the main warp yarns 13, 15 and the weft yarns 14-16 are about the same size. It is apparent, however, that many different sizes and types of yarns may be used in forming the fabric 10 in accordance with this invention.

Since, in the preferred embodiment, the weft yarns 14, 16 extend lengthwise of the Fourdrinier belt fabric and are endless to the extent that each weft yarn extends around the belt fabric 10 in a generally helical configuration, it will be noted that the weft yarns 14, 16 are substantially straight, thereby further contributing to the lengthwise dimensional stability of the endless Fourdrinier belt fabric. The warp yarns 13, 15, on the other hand, curve over, between and under the weft yarns. Thus, the warp yarns 13, 15 are formed with knuckles where they loop over and under the respective weft yarns 14, 16, which knuckles constitute the wearing surfaces of the Fourdrinier fabric.

It is thus seen that I have provided an improved multi-ply Fourdrinier forming belt fabric which is especially constructed to withstand flexing, high tension and abrasion incidental to paper manufacture, thereby enhancing the useful life of the fabric. It is seen further that the fabric comprises at least two interconnected plies, each of which is formed of respective interwoven warp and weft yarns with the interconnected plies being endless and including at least a top or face ply and a bottom or backing ply. The fabric plies are woven in a fine mesh with at least 9 percent of the area thereof being open with the openings or interstices therein being of substantially the same size and substantially uniformly distributed throughout the fabric 10. In other words, at least about 9 percent of the area of each ply throughout the fabric is devoid of any yarns to accommodate the free flow of draining liquid therethrough generally perpendicular thereof.

The 9% open area through the belt fabric 10 generally is suitable to accommodate a slurry of pulp and water containing relatively short and fine fibers during the formation of a sheet of paper or the like thereon. In instances where the fibers of the slurry are appreciably longer, it is apparent that a more open mesh weave may be employed. In any event, the open area of each ply should be such as to permit a rate of drainage of the liquid therethrough facilitating the formation of a sheet of paper of the desired quality upon the outer or face surface of the Fourdrinier forming belt fabric.

As indicated earlier herein, when the belt fabric is in use, the inner ply 12 thereof is subjected to the larger portion of the wear of the composite fabric, thereby generally protecting the warp and weft yarns 13, 14 of the face ply from frictional wear, since a substantially greater portion of the frictional wear occurs on the back or inner side of a Fourdrinier forming belt fabric than that occurring on the face or outer side thereof;

e.g., the inner ply may creep in frictional engagement with the various rolls and may slide over and against foils, suction box tops and other supporting surfaces of a Fourdrinier forming machine. Also, it is apparent that the inner ply 12 not only reinforces the top or outer ply 11, but it also enhances the dimensional stability of the Fourdrinier forming belt fabric. The stability of the Fourdrinier fabric 10 may be further enhanced by bonding the two plies 11, 12 together at suitably spaced areas, if desired. Such bonding may be effected by use of a suitable adhesive and/or by heat fusion of the plies together at such spaced areas.

It is preferred that the fabric 10 is woven in endless form, as described herein, so that the weft yarns thereof will extend lengthwise around the Fourdrinier belt formed therefrom. It is apparent, however, that the fabric may be woven of the desired weftwise width and in indefinite warpwise lengths, after which the fabric may be cut to the desired warpwise lengths and opposite ends thereof then may be suitably spliced together to form an endless Fourdrinier belt therefrom.

In the drawings and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed is:

1. A Fourdrinier fabric comprising at least two woven plies of respective sets of weft yarns and warp yarns, binder warp yarns interwoven with and interconnecting said two plies, and each of said plies being in the form of a mesh weave having an open area of at least about 9% per square inch thereof.

2. A Fourdrinier fabric according to claim 1, wherein both of said plies are endless with one ply surrounding the other ply.

3. A Fourdrinier fabric according to claim 1, wherein one of said plies is an outer ply and the other of said

plies is an inner ply, the warp yarns of each ply extending transversely across the width of the fabric, and the weft yarns in each ply extending lengthwise and around the fabric so that each ply is of substantially endless form with the weft yarns in said outer ply encircling said inner ply.

4. A Fourdrinier fabric according to claim 1, wherein the warp yarns in the two plies are approximately the same size.

5. A Fourdrinier fabric according to claim 1, wherein said weft yarns and said warp yarns in the two plies are synthetic yarns.

6. A Fourdrinier fabric according to claim 1, wherein said binder warp yarns are substantially smaller than said warp yarns in the two plies.

7. A Fourdrinier endless belt fabric comprising a pair of superposed outer and inner endless woven plies of respective sets of weft yarns and main warp yarns, binder warp yarns interwoven with an interconnecting said outer and inner endless woven plies, the warp yarns of each ply extending transversely across the endless belt fabric, the weft yarns in each ply extending lengthwise thereof and around the belt fabric in substantially endless form, all of the yarns being multifilament synthetic yarns, and each of the plies being a mesh weave having interstices therethrough forming an open area of at least about 9% per square inch of each ply with the interstices of each ply being substantially uniformly distributed throughout the respective ply for permitting liquid to drain through the Fourdrinier belt fabric.

8. A Fourdrinier fabric comprising at least two woven plies of respective sets of weft yarns and warp yarns, binder yarns interwoven with an interconnecting said two plies, and each of said plies being in the form of a mesh weave having an open area of at least about 9% per square inch thereof.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,885,602
DATED : May 27, 1975
INVENTOR(S) : Philip H. Slaughter

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, CLAIM 7, Line 19, "an" should be --and--

Signed and Sealed this
twenty-sixth Day of August 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,885,602 Dated May 27, 1975
Inventor(s) Philip H. Slaughter

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 34, "an" should be -- and --.

Signed and Sealed this

sixteenth Day of *September* 1975

[SEAL]

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