Dec. 23, 1958 D. V. ASTEN 2,865,409

# DRYER FELT FOR FINE QUALITY PAPER

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FIG. 1.

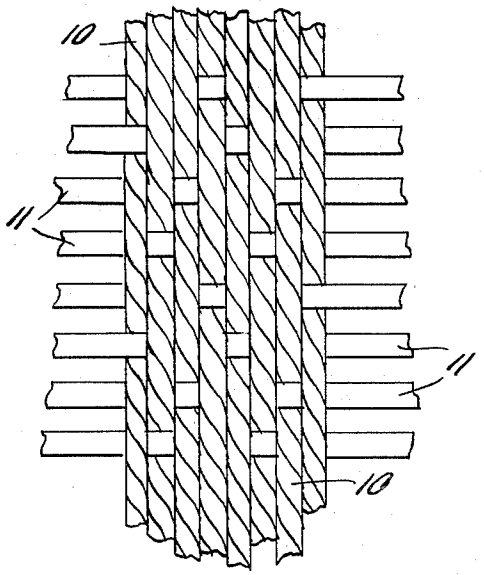
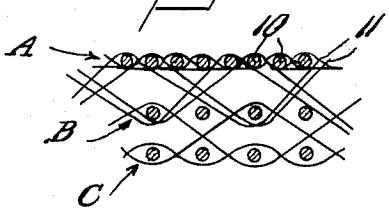



FIG. 2.

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# DRYER FELT FOR FINE QUALITY PAPER

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9 Claims. (Cl. 139—426)

This invention relates to dryer felts for paper-making machines and the like and is directed more particularly to a dryer felt that is especially adapted for the production of fine quality paper.

Heretofore, the manufacture of fine quality paper in sheets of undeterminate length on conventional paper-making machines has been a troublesome undertaking. As is well known, in such machines the moist web of fibrous material is supported by means of a dryer felt or blanket for conveyance between squeeze rollers and over the periphery of drying cylinders heated by steam or hot air. In the past, where these dryer felts have been formed of cotton or cotton and asbestos, it has been difficult to develop on the surface of the felt, that is the face of the felt in direct contact with the paper web, a finish that was suited for the production of high-quality paper, such as bond-grade writing paper and the like. Such paper must have a smooth, unmarked surface, that is, a surface that is free of defects, such as depressions, striations, streaks, wrinkles and the like. Being in direct contact with the felt during the pressing and drying operation, the moist web is an exact mirror image of the felt, taking on any and all of the surface aberrations of the felt; hence, paper having the necessary characteristics can be formed only on a felt having a soft smooth surface. Both asbestos and cotton, when formed into yarns, require a relatively high degree of twist in order to possess any substantial degree of strength and continuity, the weakness of low-twist yarns being due to the lack of coherence of asbestos fibers and to the shortness in the length of the cotton staple fibers. When high-twist yarns are woven into dryer felts, however, it is virtually impossible to construct and/or finish these felts in such a way as to achieve a smooth soft surface since such yarns are hard and even when subjected to appropriate finishing operations tend to give to the felt the characteristic appearance of a woven fabric, which would be clearly visible in the surface of paper if such a felt were employed for its formation.

In accordance with the present invention, it has been discovered that a felt having good strength and durability, even when used under severe conditions, but nevertheless possessing a soft smooth surface ideally suited for the production of high grade paper may be obtained by incorporating in the felt at the surface destined for contact with the moist paper web yarns having special characteristics that are constituted virtually entiretly of synthetic polyester staple fibers obtained by the condensation of a polymethylene glycol with terephthalic acid. The manufacture of synthetic polyester fibers per se does not form a part of the present invention. In general, however, it may be said that these fibers are derived from the reaction of a particular dibasic acid with a compound selected from a particular class of dihydroxy alcohols. The particular dibasic employed for this purpose is tere- or paraphthalic acid having the formula

$$C_6H_4(COOH)_2$$



The class of dihydroxy alcohols that is suitable is the polymethylene glycols, having the generic formula $C_nH_{2n}(OH)_2$ where $n$ varies from 2 to about 10. The preferred member of this class of alcohols is polyethylene glycol because of its ready availability at reasonable costs. Fibers of polyethylene terephthalic may be obtained from the E. I. du Pont Company, being sold by that company under the trade-mark "Dacron."

To be suitable for use in the present invention, the polyester yarns must have certain characteristics. First, they must be relatively large and bulky in order that a relatively large mass of polyester staple fibers may be concentrated at the surface of the felt, this mass being necessary to form a resilient cushion for the paper web and to provide a quantity of polyester fibers such that the surface of the felt is composed essentially or predominantly of polyester fibers to the exclusion of any other fibers that may be employed. By means of experimentation, it has been determined that these yarns may vary from three-fourths to two and one-half runs, a run being the equivalent of 1,600 yards of yarn per pound of fiber, one run being the preferred practice. Second, a soft, that is low, twist is essential. This low twist avoids repression of the inherent resiliency of the polyester fibers and permits this resiliency to have its full effect in the felt. In addition, it enables the heavy polyester yarns to spread out or expand over any underlying or infraposed yarns as well as other yarns of different fibers and/or character which may be woven with the polyester yarns to form the surface of the felt. To this end, 2–4 turns per inch is suitable with a twist of two and one-half turns per inch being preferred. It is, of course, desirable, even essential from a practical standpoint, for the polyester yarns to contribute to the tensile and/or bursting strength of the felt. Where the polyester yarns are formed of staple fibers and have the requisite very low degree of twist, the length of the individual polyester fibers from which the yarn is formed must be relatively great if the yarns are to possess an adequate degree of coherency or continuity essential to withstand tensile stress. For this purpose, the individual fibers may vary in length from about three to six or somewhat more inches, a five-inch staple being satisfactory in every respect.

The size of the individual fibers is of no great consequence, provided their combined bulk is in the range already specified, and virtually all sizes that are currently available may be employed. Specifically, individual fiber sizes of 3 to 6 or more denier are suitable.

It may be stated that for the purposes of the present invention yarns formed of polyester fibers have been found to be vastly superior to yarns formed of any other commercially available fiber, either natural or synthetic. Most important among the properties of polyester fibers which contribute to their superiority in this field is their resiliency, which is unexcelled among all textile fibers. By virtue of this property, the polyester yarns serve as a yieldable cushion for the moist paper web, uniformly and pliantly supporting the web over its entire area. When the paper web and felt are subjected to pressure, as during passage through the presser rolls of the paper-making machine, the polyester yarns at the surface of the felt do not remain firm or fixed, which would result in a transferral of their pattern to the surface of the web, but rather give way to this pressure, the individual yarns merging and blending into a smooth even-textured surface that produces in a level velvety finish on the surface of the paper.

In addition to resiliency, the polyester fibers possess other properties which cause them to be peculiarly suited for use in the paper-making art. For example, these fibers are characterized by outstanding resistance to rela-

tively high temperatures, equal or greater than those that will normally be encountered in the drying stages of the paper-making machine; the fibers can, in fact, withstand prolonged exposure to temperatures approaching about 250° C. They are quite satisfactory from the standpoint of resistance to abrasion and wear resulting from frictional contact with moving surfaces. Their ability to withstand attack by such chemicals as may be employed in making paper is particularly good. For example, they possess good resistance to most mineral acids and to weak solutions of most organic acids; they have good resistance to weak alkalies but are subject to decomposition by strong alkalies at high temperatures; and they possess good or excellent resistance to bleaching agents and many other chemicals. Their tensile strength, particularly when in continuous filamentary form, is fully comparable with highly twisted cotton yarns and this strength is maintained over long periods of time even when subjected to drastic processing conditions.

In accordance with the preferred aspect of this invention, it is contemplated that the felt be constructed of a plurality of plies of interwoven yarns, which may vary in number from about two to five, the individual plies being connected together during the weaving thereof into a more or less integral "laminate" by means of sections of yarn derived from one of the plies and floated around yarns from other of the plies in any one of a variety of ways. The weaving of multi-ply fabrics in a single operation by the use of a plurality of warps and filling yarns is a well-developed facet of the textile art and does not require a detailed discussion here. Most commonly used in the industry are felts having two plies, three plies, and a hybrid between these two, having three warps and two fillings. All multi-ply felts have at least two plies in common, one ply that is adapted for direct contact with the paper web, which in this discussion is denominated the "surface" ply, and a second ply remote from the paper web, which may be called the "backing" ply.

It is intended that the filling of the surface ply will be formed from the relatively large loosely-twisted polyester yarns.

Such yarns might also be used in the warp rather than in the filling were it not for the practical difficulties in weaving loosely-twisted warp yarns, these difficulties being so great as to virtually preclude this possibility. In keeping with the customary procedure in felt-making, the twist in the polyester filling yarns should be in the same direction throughout as a mixed twist would probably not give the desired results.

The nature and characteristics of the yarns which with the polyester staple yarns constitute the surface ply and all yarns in the backing ply and any plies that may be intermediate these two are not of particular importance to the successful practice of this invention and will be largely a matter of the individual preference of the manufacturer although certain principles may be followed to good advantage in the selection of these other yarns. The synthetic polyester fibers are hydrophobic, which is to say that they have virtually no affinity for water, absorbing less than one percent. As one of the principal functions of the felt is to absorb moisture from the damp paper web with which it is in contact, it is desirable, if not essential, that the felt include in one or more plies yarns formed of fibers that do have an ability to absorb water and can thus contribute to the drying of the paper web. For example, the yarns that extend in one or both directions of the weave in the backing ply and in any intermediate plies, as well as the crossing yarn in the surface ply, may be formed of more absorbent fibers, such as cotton and the like. In many cases, particularly where the felt is likely to be subjected to high temperatures and/or high concentrations of chemicals having a deleterious effect, it is desirable to reinforce the felt with polyester yarns, preferably formed of continuous filaments, which are more highly twisted than the polyester staple yarns in the surface ply.

Such yarns add to the strength and effective life of the felt. They may be woven with the polyester staple yarns in the surface ply and, when so used, do not detract materially from the smoothness of the face of the felt since they are essentially shielded from the paper web by the staple yarns. In addition, continuous filament polyester yarns or highly twisted yarns of polyester staple fibers or of blends of such fibers with other fibers, such as cotton, may be utilized in the backing and intermediate plies, if any, to further enhance the characteristics of the felt. The extent to which additional reinforcing polyester yarns are employed will be principally dependent upon the degree of tensile strength and durability which it is desired to build into the felt. It will, of course, be understood that minor proportions of other fibers can be incorporated in the felt, especially in the regions thereof which are relatively remote from the paper web, although, as a practical matter, synthetic fibers, other than polyester fibers, do not usually contribute to the life of the felt to an extent commensurate with the increase in cost resulting from their inclusion.

To provide as smooth a face as possible on the surface ply and to facilitate the spreading and blending action of the polyester yarns, the use of a variety of relatively open weave constructions in the surface ply is intended. The weave that is best suited for and is preferably employed in the invention is one in which the polyester yarns have successive floating portions passing over from two to about five ends of the crossing yarn in the ply before re-entering the fabric and looping under preferably no more than one end of the crossing yarn before re-emerging in another float. The pattern of the floats is staggered, which is to say that if a float in one polyester yarn begins between two ends of crossing yarns, the corresponding float in the next adjacent polyester yarn begins between one of these ends and the immediately subsequent crossing end and so on. The sequence in which the floats are woven is interrupted or broken every several, for instance, four, ends of the polyester yarn. In other words, the floats are not regularly staggered across the entire felt but every four or so ends of polyester yarn one sequence of floats is stopped and another sequence begun in non-consecutive order with the first sequence. Constructions of this type are known in the textile art as a broken twill or sateen. As the floats are staggered in a broken pattern, the depressions between floats are not in alignment for an appreciable distance in any possible direction, whether longitudinal, transverse, or oblique, which would result in a visible striation across the surface of the paper. Further, the depression between any two floats is juxtaposed with another float which can therefore spread into the depression and compensate for the surface irregularity that might otherwise be apparent. Although sateen and broken twill weaves are especially recommended, other open weaves, such as basket-weave, may be employed with less outstanding but generally adequate results.

Since polyester yarns, as currently available, exhibit a tendency to shrink, particularly when exposed to high temperatures, it is preferred that they be stabilized against shrinkage before weaving. Thus, these yarns may be "heat set" in any one of a number of ways, such as placing them in a steam chest for a suitable length of time or passing them through a heated chamber or over a heated member while they are being twisted or in a separate throwing operation.

After the felt is woven, it may be subjected to conventional brushing or napping operation to raise fibers from the polyester staple yarns and give a soft fluffy finish to the face of the felt.

A felt constructed in accordance with the present invention is illustrated more or less diagrammatically in the drawings in which

Fig. 1 is a plan view on an enlarged scale of a fragment of the felt; and

Fig. 2 is a schematic section in extended order through a portion of the felt.

In the drawings, the filling in the top ply, which is of polyethylene terephthalate yarns, is designated **10** while the warp is designated **11**. The three plies (Fig. 2) are identified by the letters A, B and C, respectively, from top to bottom. The weave is sateen with filling floats extending over three and under one warp yarns.

A better understanding of how the principles of the present invention are put to practical use may perhaps be derived from the following example which is provided only for purposes of illustration.

*Example I*

A three-ply felt having a total of 54 ends per inch and 64 picks per inch was woven, the surface ply being made up of 32 picks per inch of a one-run yarn spun from 3-inch polyester staple fibers with 2½ turns per inch of **S** twist and 27 ends per inch of a yarn plied with 5 turns of **S** ply twist from 5 strands of 10 count (cotton system) staple polyester having an initial twist of 9 turns per inch in the **Z** direction. The backing and intermediate ply were both formed of yarns plied with 5 turns per inch of **S** twist from 5 strands of 8-count cotton having an initial twist of 9 turns per inch **Z**. The felt was napped and gave excellent results when used for the production of high grade paper.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A dryer felt for high quality paper constructed of a plurality of plies woven in a relatively open construction from warp and filling yarns, one face of the felt being adapted to directly contact the paper during its manufacture, in which the yarns in the filling of the ply forming said face are relatively heavy in weight and soft in twist, being spun exclusively of polyester fibers.

2. The felt as in claim 1 wherein said face of the felt has a nap thereon.

3. A dryer felt for high quality paper constructed of a plurality of plies woven from warp and filling yarns, one face of the felt being adapted to directly contact the paper during its manufacture, in which the yarns in the filling of the ply forming said face are relatively heavy in weight and soft in twist, being spun exclusively of polyester fibers and said face is constituted essentially by floats of said polyester yarns closely spaced both warpwise and fillingwise and staggered in an interrupted pattern thereover.



4. A dryer felt for high quality paper comprising a multi-ply assembly of warp and filling yarns, the yarns in the filling in the surface ply being spun exclusively of polyester fibers having a weight of about .75–2.5 runs and a twist of about 2–4 turns per inch, said yarns being woven with portions floating over a plurality of the other yarns in the surface ply, said floating portions being closely spaced both warpwise and fillingwise and being staggered in an interrupted pattern over the surface of the ply.

5. A dryer felt adapted for use in the manufacture of high quality paper and constructed of at least two interconnected plies, each of which is woven from a series of warp and filling strands, the filling in the surface ply being constituted by yarn spun in its entirety from polyester staple fibers from 3 to about 6 inches in length, said yarn ranging in weight from about ¾ to 2½ runs and in twist from about 2–4 turns per inch, the strands in said series being woven with successive floats at the outer face of said one ply, each of said floats passing over a plurality of strands and under about one strand in the other series, the floats being staggered in small groups compared to the number of strands in the series.

6. The felt as in claim 5 wherein said fibers are formed of polyethylene terephthalic polymer.

7. The felt as in claim 5 wherein said polyester yarn has a weight of one run and a twist of 2½ turns per inch.

8. The felt as in claim 5 wherein said polyester yarn is stabilized against dimensional changes before incorporation in the felt.

9. The felt as in claim 5 wherein the face of the felt having the floats has a nap thereon.

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