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METHOD OF MAKING UNIFORM PAPERMAKERS' FELTS WITH PRE-DYED GUIDE LINES**Andrew F. Blackburn, Appleton, Wis., and Alexander A. Lukshin, Washington, D.C., assignors to Appleton Mills, a corporation of Wisconsin****No Drawing. Filed June 30, 1959, Ser. No. 823,821****5 Claims. (Cl. 28—75)**

This invention relates to an improved method of making papermakers' felts consisting predominantly of synthetic thermoplastic fibers and, more particularly, to a method for making such felts having dyed guide lines thereon of the same fiber composition as the remainder of the felt, and having the same shrinkability, twist and other properties necessary for uniform processing and finishing of paper.

Papermakers' felts are employed in the manufacture of paper to pick up freshly laid web of wet paper or pulp from the forming wire; to conduct the web through the paper finishing presses; and to remove water from the paper in press sections or the like. Papermakers' felts must have a high degree of dimensional stability, properties permitting the felt to pick up and retain the fibers of the paper during the processing thereof and be of sufficient porosity to permit rapid removal of water from the freshly laid pulp. These properties of the felt must be uniform throughout the felt if the paper produced or finished on the felt is to be uniform in quality.

Felts employed in the papermaking industry have been predominantly all natural wool as experience has shown that natural wool felts have the necessary strength, closeness of weave and dimensional stability to render them suitable for such use. Notwithstanding the current use of papermakers' felts woven from natural wool or blends of wool and synthetic materials containing sufficient wool to render the fabric fullable, such felts have been an expensive item for the industry as the life of a good all-wool felt is relatively short.

In United States patent application Serial No. 767,109, L. R. Mizell, filed October 14, 1958, a method of making improved papermakers' felts consisting substantially entirely of synthetic thermoplastic fibers is disclosed whereby the finished felts having better dimensional stability, improved wear resistance, better water removal properties, and improved chemical and bacterial resistance over the conventional wool-containing woven felts are produced.

With the discovery of a method of making papermakers' felts predominantly of synthetic thermoplastic fibers, the papermaking industry was provided with felts having improved physical properties; however, such synthetic felts presented problems in providing them with colored guide lines. Substantially all papermakers' felts, as supplied to the paper mills, contain spaced filling yarns dyed with a color contrasting to the remainder of the felt. These dyed yarns, which extend across the width of the felt, serve as guide lines so that paper machine operators can more easily run the felt straight on the machine.

It is a primary object of the present invention to provide a method of making papermakers' felts having dyed guide lines of the same fiber composition as the remainder of the felt, and having the same shrinkability, twist and other properties necessary for uniform processing and finishing of paper.

A further object of the present invention is to provide such a method wherein synthetic fiber felts can be washed and/or chemically treated, following the conventional burling operation and then dye-set, shrunk,

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heat-set and cured, all in one continuous operation on the same machine.

These and other objects and advantages of the invention are provided by the method of making papermakers' felts composed predominantly of heat-shrinkable synthetic fibers or filaments having dyed guide lines comprising subjecting a portion of said synthetic fibers to a disperse type dye in a water-alcohol system maintained at a temperature not exceeding about 125° F., drying said portion of the fibers at a temperature not exceeding the temperature of the dye bath; weaving and where desired, burling a fabric from said synthetic fibers, incorporating as guide lines said dyed and dried portion; placing said fabric under tension; heating the tensioned fabric to establish a temperature in the fabric of from about 200° F. to about 400° F. to provide thermal shrinkage in the fabric, heat-set the fabric and set the dye in the dyed portion of the yarns.

In making papermakers' felts in accordance with this invention, a wide variety of synthetic heat-shrinkable fiber, filaments or blends of natural and synthetic fibers or filaments may be employed in the process as long as the synthetic fibers are capable of taking and retaining a set at a temperature above that ordinarily encountered in the use of papermakers' felts and are capable of shrinking or retracting when subjected to temperatures higher than normally encountered on the papermaking machines. Among the fibers having such qualities are fibers known as Dacron, nylon, dynel, Orlon and the like.

Dacron is a synthetic polyester fiber made by the condensation of dimethyl terephthalate and ethylene glycol; dynel is a synthetic fiber made by the copolymerization of, for example, 40% acrylonitrile and 60% vinyl chloride; nylon is a term applied to a series of fibers made of polyamide resins typically formed by the polymerization of a hexamethylenediamine salt of adipic acid; while Orlon is a synthetic fiber made principally from polyacrylonitrile.

The synthetic fibers enumerated are often supplied by the manufacturers in the form of staple fibers to resemble a natural wool fiber. Such fibers may be straight length fibers or crimped, curled or spiraled to more nearly approximate the natural wool fibers they replace and the fibers can be lustrous, dull, or semi-dull in appearance.

Also Dacron, nylon, polypropylene and other synthetic materials are supplied in multiple filament yarn form. These materials may be employed in making papermakers' felts in the supplied form or they can be texturized or bulked prior to weaving or dyeing.

When staple fibers are employed in the process of the invention the fibers to form the guide lines may be dyed in bulk form or first carded and spun prior to dyeing. When the material for the papermakers' felts is supplied in the yarn form, the yarns may be dyed in accordance with the invention on spindles or bobbins or the yarn may be removed therefrom and formed into skeins prior to dyeing. Therefore, hereinafter and in the claims appended hereto, the term "fibers" includes bulk staple fibers, yarns spun therefrom, and multiple filament yarns in the bulked or unbulkied form.

While there are a large number of synthetic fibers which may be employed satisfactorily in making papermakers' felts in accordance with the teachings of this invention, the preferred fibers are Dacron or nylon as they have been found to be the most durable fibers in papermakers' felts. The Dacron or nylon or a combination of these fibers can be used in both the warp and the filling yarns, or one of the fibers can be used in the warp and the other in the filling.

After selecting the heat shrinkable synthetic fibers

which are to be woven in substantially the same way that wool and/or wool synthetic fibers are processed on the woolen or worsted system into papermakers' felts, a portion of the synthetic fibers which will comprise the guide lines for the finished papermakers' felts are dyed with a color which contrasts with the color of the remainder of the felt so that the paper machine operators may run the felt satisfactorily. As hereinbefore pointed out, the colored filling yarns for the guide lines must have the same fiber composition, shrinkability, twist and other properties as the other filling yarns in the felt.

In forming the papermakers' felts from a thermoplastic heat shrinkable synthetic fiber, it is necessary to dye the yarns for the guide lines at a low temperature, substantially room temperature, so that the yarns will not shrink or be heat-set before the final finishing of the entire felt. Other requirements of the dyed yarns for the guide lines are that they should be: generally colored uniformly, resist leaching and bleaching in papermill finishes, and give the same functional performance as to wear, water removal, surface smoothness, and the like as the undyed filling yarns to be woven into the same papermakers' felts.

It has been found that the yarns for forming the guide lines in the felts may be satisfactorily dyed with disperse type dyes soluble in water and alcohol commonly used for dyeing cellulose acetate from dispersions. Typical disperse type dyes useful in the invention are Celanthrene Brilliant Blue FFS (200% Disperse Blue No. 3) and Acetamine Scarlet B (new C.I. Disperse Red No. 1).

Example 1

The amount of filling yarn to be used as guide lines is preferably removed from the bobbins and placed in skein form.

A dye bath is made up at a liquor to yarn weight ratio of about 25 to 1. The dyeing solution contains 10% of a disperse type dye (e.g., Color Index Disperse Blue 3), based on the weight of the yarn, and a saturation concentration of benzyl alcohol in water at room temperature. At 80° F., the concentration of benzyl alcohol is 4% based on the total weight of the solution. The solution is stirred to allow complete dispersion of the dye in the aqueous benzyl alcohol. The skeins of yarn are placed in the dye bath for one hour, while the liquor is stirred or circulated through the yarn. After one hour at room temperature, the yarn is removed from the dye bath, rinsed for about 10 minutes in cold water, and then washed for approximately 10 minutes with a 1% solution of a non-ionic type surface active agent such as Nonic 218, a polyethylene glycol tertiary dodecylthioether, at room temperature to level the dye in the yarn. The yarn is then rinsed in cold running water until the surface active agent is removed, and extracted to remove excess water. A centrifugal extraction will leave only about 25% by weight of water in the yarns. The skeins (or packages) of yarn are air dried at room temperature.

At this stage the dyed and air-dried yarns are ready to be woven into the felt in the manner as to be more fully described hereinafter.

Example 2

A dye bath is made up containing about 10% of Celanthrene Brilliant Blue FFS 200% based on the weight of the yarn and a saturated concentration of butyl alcohol in water at room temperature. The solution is thoroughly stirred to allow complete dispersion of the dye in the aqueous butyl alcohol. The skein of thermoplastic heat shrinkable yarn is placed in the dye bath and stirred to thoroughly bring the dye solution into contact with all portions of the yarn. The skein of yarn is removed after about one hour and rinsed in running water at about room temperature. The dye in the skein of yarn is levelled with a 1% solution of a non-ionic surface active agent for about 10 minutes

and then again rinsed in running water at room temperature. The re-washed skein of dyed yarn is allowed to dry at room temperature and at this stage the dyed and air-dried yarns are satisfactory for weaving into the felt.

Example 3

A dye bath is made up of a dyeing solution containing about 10% of Setacyl Black 2RF based on the weight of the yarn and a saturated concentration of isobutyl alcohol in water at room temperature. The solution is stirred to allow complete dispersion of the dye in the aqueous isobutyl alcohol. The skeins of yarn are placed in the dye bath for about one hour and the liquor is stirred or circulated to thoroughly bring the dye into contact with the yarn. After about 1 hour at room temperature, the yarn is removed from the dye bath, rinsed for about 10 minutes in running water at room temperature and then washed for approximately 10 minutes with a 1% solution of a non-ionic type surface agent to level the dye in the yarn. The yarn is again rinsed in running water at room temperature and the excess water removed by centrifugal extraction. The dyed yarns are air dried at room temperature and at this stage the dyed and air-dried yarns are suitable for weaving as guide lines into papermakers' felts.

Example 4

A dye bath is made up containing about 1% of Amacel Brilliant Blue B extra super (New Color Index No. 3) based on the weight of the yarn and a saturated concentration of benzyl alcohol in water at about room temperature. When the dye is fully dispersed in the aqueous benzyl alcohol, the yarn is placed in the dye bath and the bath is stirred to bring the dye solution into contact with all portions of the yarn. The yarn is removed from the dye bath after about 1 hour and washed in water containing about 1% of a non-ionic surface active agent, rinsed in water and allowed to dry. The dry yarns are then ready for weaving into papermakers' felts.

The concentration of the dye bath is in general not critical and may be varied within substantial limits. For example, satisfactory results may be obtained when the dye bath contains from about 1 to over 10% of 100% to 200% dyeing agent based on the weight of the yarn.

A papermakers' felt employing as a portion of the filling yarns, the yarns dyed as set forth in the examples are processed through the steps of weaving, splicing, if not woven endless, and burling of the synthetic yarns into a woven felt. The woven fabric at this stage is placed on a conventional treating device wherein the felt is shrunk in width by mechanical stretching in length; heat-shrunk in width; and then heat-set to stabilize the length and the width of the fabric and to set the dye in the filling yarns forming the guide line. One form of apparatus suitable for carrying out the finishing of the fabric is disclosed in copending application Serial No. 767,109, L. R. Mizell, filed October 14, 1958, for "A Method for Making Papermakers Felts."

In general, heat or thermal shrinkage; heat-setting of the fabric and setting the dye in the guide line thereof may be very satisfactorily carried out by exposing the felt to heat for a period of from about 30 seconds to about 90 seconds at a fabric temperature of from about 200° F. to about 400° F. However, the preferred heating conditions for thermal shrinkage of dry fabrics are from about 30 to about 60 seconds exposure to heat to provide a fabric temperature of from about 350° to about 370° F. as it has been found that under these conditions, maximum thermal shrinkage is provided without scorching or fusing of the synthetic fibers of the fabric. Following the heat-shrinking step, it has been found, in general, that an additional exposure of time of about 1 minute to heat to provide fabric temperatures of from

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about 350° F. to about 400° F. the felt dimensions are set to within 2% or 3% of their permanent dimensions and the dye in the filling yarns of the guide lines is set.

From the foregoing description of the present invention, it will be seen that the aims and objects thereof are fully accomplished by the improved process whereby papermakers' felts composed predominantly of thermoplastic synthetic fibers are provided with colored guide lines wherein the guide lines are uniformly colored, resist leaching and bleaching in papermill finishes and give the same functional performance of wear, water removal, surface smoothness and the like as the undyed portion of the synthetic thermoplastic papermakers' felts. While details of methods for carrying out the improved process have been disclosed, it will be understood by those skilled in the art that variations may be made in the processes without departing from the inventive concepts thereof.

We claim:

1. The method of making papermakers' felts composed predominantly of heat-shrinkable synthetic fibers having dyed guide lines comprising subjecting a portion of said synthetic fibers to a disperse type dye in a water-alcohol system maintained at a temperature not exceeding 125° F.; drying said portion of the fibers at a temperature not exceeding the temperature of the dye bath; weaving a fabric of said synthetic fibers incorporating as guide lines said dyed and dried portion; placing said fabric under tension; heating the tensioned fabric to establish a temperature in the fabric of from about 200° F. to about 400° F. to provide thermal shrinkage in the fabric, heat-set the fabric and set the dyed portion of the yarns whereby the woven felt including the dyed guide lines has substantially uniform structure.

2. The method of making papermakers' felts composed predominantly of heat-shrinkable synthetic fibers having dyed guide lines comprising subjecting a portion of said synthetic fibers to a disperse type dye in a water-alcohol system maintained at a temperature not exceeding 125° F., leveling the dyed fibers in an aqueous solution of a non-ionic surface active agent, drying said portion of the fibers at a temperature not exceeding the temperature of the dye bath; weaving a fabric of said synthetic fibers incorporating as guide lines said dyed and dried portion; placing said fabric under tension; heating the tensioned fabric to establish a temperature in the fabric of from about 200° F. to about 400° F. to provide thermal shrinkage in the fabric, heat-set the fabric and set the dyed portion of the yarns whereby the woven felt including the dyed guide lines has substantially uniform structure.

3. The method of making papermakers' felts composed

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predominantly of heat-shrinkable synthetic fibers having dyed guide lines comprising subjecting a portion of said synthetic fibers to a disperse type dye in a saturated water-benzyl alcohol system maintained at a temperature not exceeding 125° F.; drying said portion of the fibers at a temperature not exceeding the temperature of the dye bath; weaving a fabric of said synthetic fibers incorporating as guide lines said dyed and dried portion; placing said fabric under tension; heating the tensioned fabric to establish a temperature in the fabric of from about 200° F. to about 400° F. to provide thermal shrinkage in the fabric, heat-set the fabric and set the dyed portion of the yarns whereby the woven felt including the dyed guide lines has substantially uniform structure.

4. The method of making papermakers' felts composed predominantly of heat-shrinkable synthetic fibers having dyed guide lines comprising subjecting a portion of said synthetic fibers to a disperse type dye in a saturated water-butanol system maintained at a temperature not exceeding 125° F.; drying said portion of the fibers at a temperature not exceeding the temperature of the dye bath; weaving a fabric of said synthetic fibers incorporating as guide lines said dyed and dried portion; placing said fabric under tension; heating the tensioned fabric to establish a temperature in the fabric of from about 200° F. to about 400° F. to provide thermal shrinkage in the fabric, heat-set the fabric and set the dyed portion of the yarns whereby the woven felt including the dyed guide lines has substantially uniform structure.

5. The method of making papermakers' felts composed predominantly of heat-shrinkable synthetic fibers having dyed guide lines comprising subjecting a portion of said synthetic fibers to a disperse type dye in a saturated water-isobutanol system maintained at a temperature not exceeding 125° F.; drying said portion of the fibers at a temperature not exceeding the temperature of the dye bath; weaving a fabric of said synthetic fibers incorporating as guide lines said dyed and dried portion; placing said fabric under tension; heating the tensioned fabric to establish a temperature in the fabric of from about 200° F. to about 400° F. to provide thermal shrinkage in the fabric, heat-set the fabric and set the dyed portion of the yarns whereby the woven felt including the dyed guide lines has substantially uniform structure.

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