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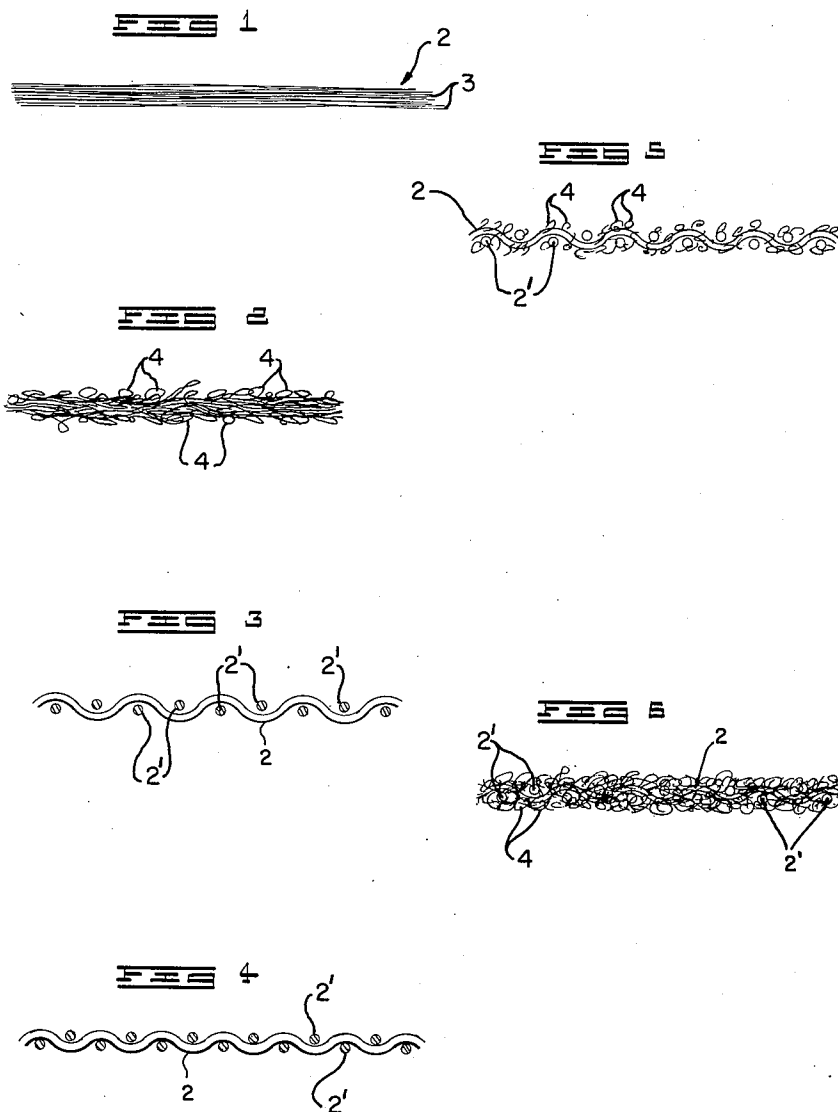
L. R. MIZELL

3,030,690

METHOD OF MAKING PAPERMAKER'S FELT

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3 Sheets-Sheet 1



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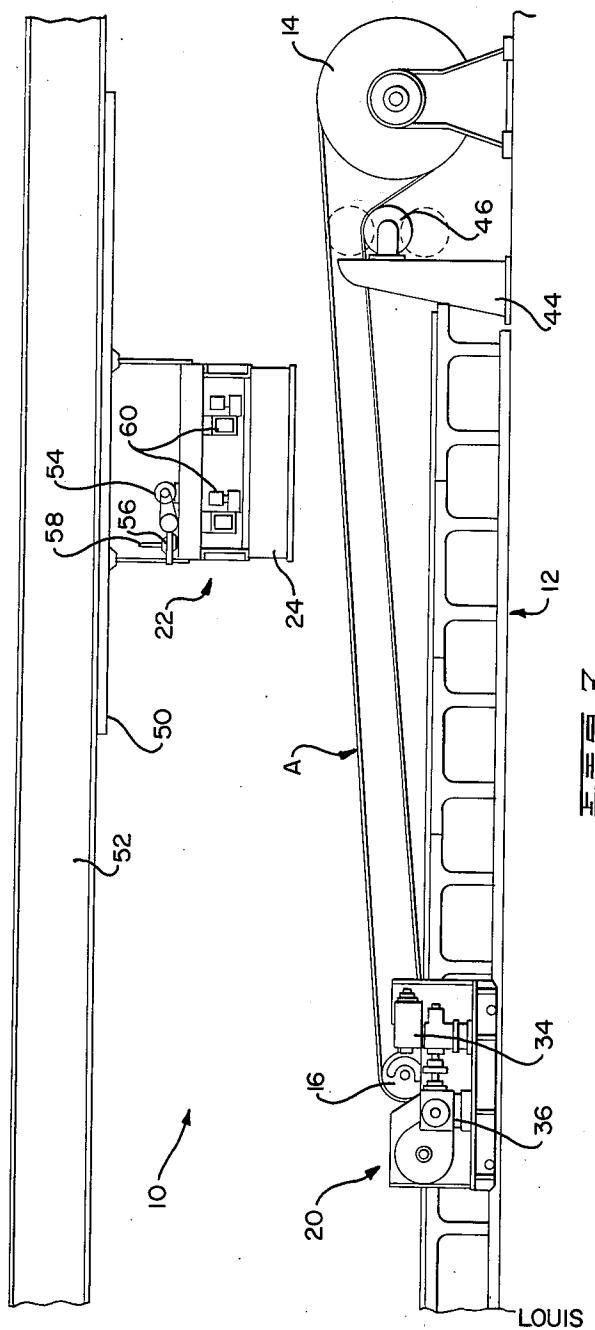
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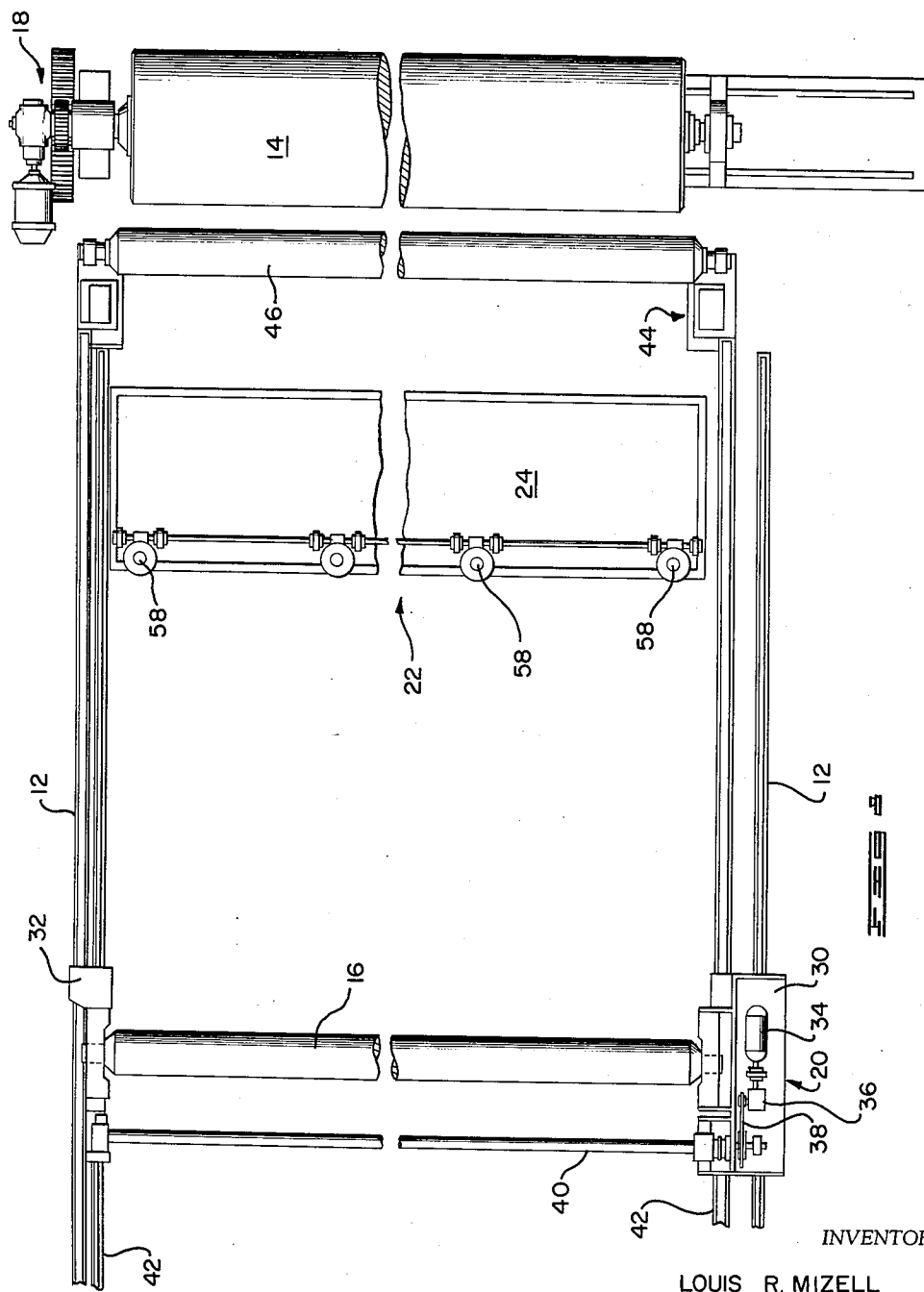
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METHOD OF MAKING PAPERMAKER'S FELT

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4 Claims. (Cl. 28—72)

This invention relates to an improved method of making papermaker's felts containing a substantial portion of continuous filament synthetic yarns.

Papermaker's felts are employed in the manufacture of paper to pick up a freshly laid web of wet paper or pulp from the forming wire and to conduct the web through the paper forming and finishing presses. Papermaker's 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 must be of sufficient porosity to permit rapid and even removal of water from the paper or pulp.

Felts employed by the papermaking industry are predominantly all natural wool as experience has shown that natural wool felts possess the necessary strength, closeness of weave, dimensional stability, and water removal properties to render them suitable for such use. Notwithstanding the current use of papermaker's felts woven from natural wool or blends of natural wool and synthetic yarns with sufficient wool to render the woven fabric feltable, the resulting 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, filed October 14, 1958, by Louis R. Mizell, of which this is a continuation-in-part, there is disclosed a method for making improved papermaker's felts consisting substantially entirely of synthetic thermoplastic fibers whereby the finished felt has better dimensional stability, improved wear resistance, better water removal properties, greater tensile strength, and improved chemical and bacterial resistance over the best conventional wool-containing woven felts.

It is a principal object of the present invention to provide a method for making improved papermaker's felts consisting entirely of or containing a substantial portion of continuous filament synthetic yarns that have been mechanically modified to provide yarns that are substantially increased in denier and bulk whereby the finished felts have greater bulk, better resiliency and a fuzzier wool-like surface than regular synthetic filament yarn felts. Such textured yarn felts also have greater strength, less fiber loss, better finish and wear resistance than staple yarn felts, and are relatively simple and inexpensive to manufacture, compared to wool felts and synthetic felts constructed from staple fibers.

A further object is to provide a method of manufacturing papermaker's felts wherein the specified finished felt dimensions are readily obtained and the finished dimensions are very stable.

A further object is to provide such a process wherein the textured synthetic yarn felts may be chemically treated, shrunk, heat-set and cured all in one continuous operation.

A further object is to provide a method of making felts wherein conventional felt weaving looms and other felt making machinery may be employed in the improved process.

These and other objects and advantages are provided in the improved method of making papermaker's felts containing a substantial portion of continuous filament synthetic yarns comprising mechanically modifying continuous multifilament yarns to substantially increase the yarn denier and bulk, and weaving a fabric from said mechanically bulked yarn.

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The invention will be more fully described with reference to the illustrative embodiments diagrammatically illustrating the principles of the invention and showing apparatus suitable for carrying out the finishing of woven synthetic felts in accordance with the teachings of the present invention wherein:

FIG. 1 is an enlarged fragmentary view of a continuous multiple filament synthetic yarn prior to mechanical modification to increase the yarn bulk;

FIG. 2 is a side view of a continuous multiple filament synthetic yarn having mechanically formed loops thereon, thereby increasing the weight per unit length of the yarn;

FIG. 3 is an enlarged fragmentary sectional view through a fabric woven from unbulked yarn;

FIG. 4 shows the fabric illustrated in FIG. 3 following heat shrinking and heat setting of the fabric in the filling direction;

FIG. 5 is a sectional view through a fabric woven from bulked yarn illustrated in FIG. 2 with the spacing of the yarns being the same as that illustrated in FIG. 3;

FIG. 6 shows the fabric illustrated in FIG. 5 after the felt has been subjected to heat shrinking and heat setting;

FIG. 7 is a side elevation of apparatus suitable for carrying out the heat shrinking and heat setting steps of the present invention; and

FIG. 8 is a fragmentary plan view of the apparatus shown in FIG. 7.

In weaving synthetic papermaker's felts in accordance with this invention, a wide variety of bulked synthetic thermoplastic filament yarns or blends of yarns may be employed in the weaving process as long as the synthetic yarns have good wearing properties, are capable of taking and retaining a set at a temperature above that ordinarily encountered in the use of papermaker's wet felts and are capable of shrinking or retracting when subjected to heat or yarn shrinking chemicals. Among the synthetic filament yarns having such qualities are Dacron, nylon, polypropylene, Orlon and the like.

Dacron is a synthetic polyester fiber made by the condensation of dimethyl terephthalate and ethylene glycol; 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.

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

Several processes are known today whereby continuous filament yarns as illustrated in FIG. 1 at 2, may be mechanically modified so that the individual filaments 3 no longer lie parallel to one another along the axis of the yarn. Fabrics made from bulked yarns have greater cover, are more wool-like and are softer than fabrics made from unmodified continuous filament yarns. Substantially all yarn bulking processes start with regular, straight multiple filament yarns which are then mechanically fluffed up or bulked to increase the weight per unit length of the finished yarns and to give the continuous filament yarns the general effects of staple fiber yarn.

One of the methods of making bulked yarn comprises passing untwisted or slightly twisted continuous filament synthetic yarns through an air jet which air jet blows loops, as illustrated at 4 in FIG. 2, at random intervals

along the individual filaments to substantially increase the weight per unit length of the yarn. United States Patents 2,783,609, Breen, and 2,829,420, Grisct, Jr., disclose methods and apparatus for air jet bulking of continuous filament yarns. It is also known to pass a pair of continuous filament synthetic yarns through an air jet at different rates of feed. One of the yarns has a relatively low rate of overfeed and becomes the "core yarn" and the other yarn is fed at a higher overfeed rate and is thereby provided with the greater number of loops, which loops are intertwined with the core yarn and becomes the "effect yarn."

Other methods of bulking continuous filament synthetic yarns involve twisting and setting, and crimping in a stuffing box and the like.

The selected synthetic continuous multifilament yarn to be woven into the improved papermaker's felts is first mechanically modified to substantially increase the yarn denier and bulk and Table I shows the change in denier of some continuous filament yarns, due to different bulking methods and conditions which have been found suitable for constructing papermaker's felts in accordance with the teachings of the present invention.

TABLE I

	Denier Before Bulking	Denier After Bulking
Nylon type 300 140-filament $\frac{1}{2}$ twist per inch (high tenacity)	840	1,202
Nylon type 100 140-filament $\frac{1}{2}$ twist per inch (high tenacity)	800	1,012
Nylon type 6 104-filament $\frac{1}{2}$ twist per inch (high tenacity)	1,500	1,786
Dacron type 51 250-filament 0 twist (Bright high tenacity)	1,100	1,332
Dacron type 51 250-filament 0 twist (Bright high tenacity)	1,100	1,310
Nylon type 6 (2 yarns 112-filaments each)	2,100 each yarn	5,160

Following the step of mechanically bulking the yarns to substantially increase the yarn denier, the yarns are woven and spliced, if not woven endless, into an endless fabric and the fabric is then ready for finishing. The endless fabric at this stage appears as illustrated in FIG. 5. The fabric is then placed on a treating device where the fabric is mechanically shrunk in width, heat shrunk in width and then heat-set to stabilize the length and the width of the fabric. The finished felt-like fabric then appears as illustrated in FIG. 6.

The effect of mechanical and heat or chemical shrinking of the fabric in width is clearly illustrated in FIGS. 3 and 4 and 5 and 6 where it will be seen that the warp yarns 2' are moved closer together in both the conventional synthetic yarn fabrics (FIGS. 2 and 3) and in the plural filament bulked synthetic yarn fabric illustrated in FIGS. 5 and 6.

One form of apparatus suitable for carrying out the felt treating steps of the invention is shown in FIGS. 7 and 8 of the drawings and is generally designated 10. The treating apparatus 10 includes a frame 12 having adjacent its ends a pair of rolls 14 and 16. The width of each of the rolls 14 and 16 is at least slightly greater than the width of the fabric to be treated and one or both of the rolls may be driven. However, as illustrated in FIGS. 7 and 8, only roll 14 is provided with conventional drive means 18, which drive means is preferably of the adjustable speed type whereby the speed of the traveling web about the pair of rollers is controlled within prescribed limits. The other of the rolls 16 is mounted in adjustable means generally designated 20 whereby the distance between the centers of rolls 14 and 16 may be variously adjusted to accommodate different size webs and to effect mechanical width shrinkage of the fabric.

The length adjusting means includes a pair of track mounted frames 30 and 32 between which the roll 16 is

rotatably mounted. A motor 34 drivably connected to a speed reducing means 36 drives, through a belt 38, a shaft 40 engaging a rack 42 extending along each of the frames 12 whereby upon actuation of the motor 34, frames 30 and 32 supporting the idler roller 16 are moved toward or away from the driver roll 14 depending upon the direction of rotation of the motor 34.

The assembly also includes a stand 44 having adjustably mounted thereon a felt roll 46 which maintains the lower flight of the felt A being treated at a predetermined position and prevents sag in the felt.

Positioned above the web or felt A, between the rolls 14 and 16, is a heating device generally designated 22 which heating device may be of the infra-red type and extends at least across the width of the felt to be treated.

The heating device 22 is adjustably supported from trackways 50 secured to support members 52. A motor 54 drives worm reduction gear units 56 which, in turn, are connected to gears (not shown) at the upper ends of shafts 58 which mesh with rack means carried by the trackways 50 whereby upon actuation of motor 54, the heating unit 22 may be shifted longitudinally over the felt being treated. As the heater 22 is moved toward the roll 16, the distance between the hood 24 and the upper surface of the felt is increased, while movement in the opposite direction, brings the upper surface of the felt closer to the reflectors in the hood 24 thus effectively increasing the heating capacity of the heater unit as is well known in the art.

The hood unit 24 may include one or more blowers generally indicated at 60 for cooling the mechanism for operating the hood positioned above the reflectors 26.

Woven synthetic felts are generally woven in the loom to a length approximately equal to the finished length for the particular paper machine. When a fabric is removed from the loom, the fabric "setsback" or relaxes in length and it has been found that the relaxation of such a fabric is from about 7% to about 15% based on the length of the loomed fabric. However, the amount of relaxation in the woven fabric in length depends to a large extent on the tension under which the warp yarns are woven, the type of felt being manufactured, the type of weave employed, and the texture or closeness of the weaving. In view of the relaxation of the woven fabric, after the fabric is placed between the rolls 14 and 16, the tensioning mechanism 20 is employed to stretch the fabric in length to about the ordered or specified length of the finished felt or to a length from about 2 to about 4 percent greater than the ordered length.

This mechanical stretching in length brings about a definite proportional amount of mechanical shrinkage in the width direction of the fabric.

After the fabric has been stretched in length to a length slightly greater than the desired finished length and mechanically shrunk in width as hereinabove described, the fabric is then subjected to thermal shrinkage in width by the application to the fabric of heat from the heater 22. It will also be appreciated that chemical shrinking may be substituted for the heat shrinking of the yarns. Following the heat or chemical shrinking in width, both the length and the width of the shrunken synthetic fabric are set with further applications of heat.

With the fabric stretched between the rolls 14 and 16 as hereinabove described, the fabric is subjected to heat from the mechanism 22 while travelling about the rolls 14 and 16. The intensity of the heat and the speed of travel of the fabric around the rolls 14 and 16 is so adjusted that the entire surface of the fabric will be exposed to the heat for a period of from about 30 seconds to about 90 seconds at a fabric temperature of from about 212° F. to about 400° F. The preferred heating conditions for thermal shrinkage of the width of the dry fabric are from about 30 to about 60 seconds exposure at a fabric temperature of from about 350° F. to about 370° F. as it has been found that under these conditions

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maximum thermal shrinkage is provided without scorching or fusing of the synthetic fibers of the fabric.

After the synthetic felt has made one complete pass under the heating unit and full thermal shrinkage has taken place in the fabric, the felt is ready for heat setting its dimensions. For heat setting, the fabric is again passed under the hood. The temperature, time, and conditions for heat setting the dimensions of the heat shrunk fabric are not as critical as the temperature and conditions during thermal shrinking thereof. For example, the heat shrunk fabric can be caused to pass six times under the hood with a 30-second exposure during each pass at a fabric temperature of from about 250° F. to about 400° F. or satisfactory results can be obtained with the fabric making three passes under the hood with a 60-second exposure during each pass at a fabric temperature of about 250° F. to about 400° F. In general, it has been found that with an exposure time of about 1 minute at fabric temperatures of from between 350° F. to about 400° F. following the heat shrinking cycle, the felt dimensions are set to within two to three percent of their permanent dimensions.

Following the heat setting of the felt, the felt may be removed from the treating apparatus and is then ready for use on a papermaking machine.

Example 1

A papermaker's felt was woven in 3/1 weave with 34 picks and 28 ends per inch employing 14-cut regular Dacron staple yarn in the warp and 1332 denier bulked continuous multiple filament Dacron yarn in the filling. The filling yarn was bulked from 1100 denier, 250 filament type 51 Dacron. This yarn was bulked by passing the yarn through an air jet providing 19% overfeed to provide after bulked, a yarn having 1332 denier. The woven fabric was removed from the loom and placed on the finished apparatus of the type shown in FIGS. 7 and 8 of the drawings where the woven fabric was mechanically stretched in length, and mechanically shrunk in width and held at that length during the remainder of the finishing process.

The intensity of the felt heating means was adjusted and the speed of travel of the felt around the rolls under the heater unit was adjusted for the thermal shrinkage phase of the felt finishing operation. The heating unit was energized and the felt was exposed to the heat to develop a temperature of from about 350° to about 375° F. in the fabric to bring about a total shrinkage in width of about 26% of the woven width. Following the heat shrinking, the length and width dimensions of the fabric were heat set by causing the felt to make additional passes under the heater. The all-synthetic felt constructed as disclosed in Example 1 was found to have very satisfactory finish, strength, and water removal properties.

Example 2

A felt was woven in 3/1 weave with 34 picks and 28 ends per inch employing continuous multiple filament Dacron in the warp and bulked continuous multiple filament nylon yarn in the filling.

The Dacron warp yarn, originally 1100 denier, and having 250 filaments per yarn was passed through an air jet at an overfeed of 12% to produce a bulked yarn having a denier of 1257. The nylon filling yarn was bulked from 840 denier 140 filament type 300 nylon continuous filament yarn passed through an air jet at a yarn overfeed of 19%. Following the weaving of the fabric, the fabric was mechanically shrunk in width; mechanically stretched in length; heat shrunk in width while maintaining the mechanically stretched length and then the fabric was heat set in width and length. The finished synthetic papermaker's felt was found to have excellent properties.

Example 3

A felt was woven in a 3/1 weave with 26 picks and 28

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ends per inch employing bulked Dacron yarn in the warp with the Dacron yarn being prepared as set forth in Example 2 and the filling yarns comprised 930 denier plied Dacron bulked yarn. The warp yarn was prepared from 1100 denier, 250-filament, bright, high tenacity Dacron bulked to 1332 denier and the filling yarn was prepared by plying together two yarns bulked as follows:

Dacron Core Yarn	Dacron Effect Yarn	Feed Through Air Jet at 65 Pounds Pressure		Take Up Speed of Yarn f.p.m.
		Core, f.p.m.	Effect, f.p.m.	
15 70 denier, 30 filament-----	250 denier, 50 filament.	159	234	147

The pairs of bulked yarns were plied together by 4.5 turns per inch and the denier of the finished yarns was 930.

The woven fabric was mechanically shrunk in width, mechanically stretched in length, heat shrunk in width, and heat set in length and width as disclosed in Example 1.

Example 4

An all-synthetic papermaker's felt was woven in a duplex weave employing bulked Dacron filament yarns in the warp and bulked nylon filament yarns in the filling. The Dacron filament yarns in the warp were prepared as set forth in Example 2 and the nylon filament yarn in the filling was prepared from two strands of nylon passed through an air jet at different speeds from multiple filament nylon as set forth below:

Core Yarn	Effect Yarn	Feed Through Air Jet at 75 pounds Pressure		Take Up Speed of Yarn, f.p.m.
		Core, f.p.m.	Effect, f.p.m.	
420 denier nylon, 68 filaments.	780 denier, 51 filament nylon.	74	176	64

A pair of the bulked nylon yarns were plied together and provided with five turns per inch of twist to provide bulked yarns of 2480 denier.

The woven fabric was mechanically stretched in length, mechanically shrunk in width, heat shrunk in width, and heat set in length and width as set forth in Example 1. The finished felt had excellent finish, strength, and water removal properties.

Example 5

A papermaker's felt was woven in a typical 2/2 pickup felt weave using 1332 denier bulked Dacron in the warp and 25% Dacron staple fiber, 75% wool, 16-cut staple yarn size in the filling. The bulked Dacron in the warp was prepared from 1100 denier, 250-filament, bright, high tenacity continuous filament yarn treated to provide 21.1% bulking with a denier of 1332. The woven fabric was finished by mechanically stretching in length, mechanically shrinking in width, heat shrinking in width, and heat setting in length and width as provided in Example 1. The finished felt had excellent papermaker's felt properties.

Example 6

A papermaker's felt was woven in an 8-harness duplex weave with 76 picks and 40 ends per inch employing 25% Dacron staple fiber, 75% wool fibers, 2/20 cut staple yarn size in the warp and 1488 denier bulked filament nylon yarn as the filling yarn on the back of the fabric and 15% nylon staple fibers, 85% wool fibers, 10-cut staple yarn size as the filling on the face of the felt. The

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1488 denier bulked filament yarn as the filling yarn on the back of the felt was double end bulked as follows:

Core Yarn	Effect Yarn	Feed Through Air Jet at 75 pounds Pressure		Take Up Speed of Yarn, f.p.m.
		Core, f.p.m.	Effect, f.p.m.	
420 denier 68 filament nylon 300.	Same-----	74	176	64

The woven fabric was finished as set forth in Example 1 and the finished felt was found to have excellent properties as a papermaker's felt.

I claim:

1. A method of making papermaker's felts containing a substantial portion of continuous filament synthetic heat retractable yarns comprising mechanically interlooping and snarling filaments of continuous multiple filament synthetic yarns to substantially increase the yarn denier and bulk, and weaving a felt-like fabric from said mechanically bulked yarn, placing the woven fabric under longitudinal tension, heating the tensioned fabric to establish a temperature in the fabric of from about 212° F. to about 400° F. to provide thermal shrinkage in the width of the fabric and then heat setting the fabric.

2. A method of making papermaker's felts containing a substantial portion of continuous filament synthetic heat retractable yarns comprising mechanically interlooping and snarling filaments of continuous multiple filament synthetic yarns to substantially increase the yarn denier and bulk and weaving a felt-like fabric, employing said mechanically bulked yarn in the warp, placing the woven fabric under longitudinal tension, heating the tensioned

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fabric to establish a temperature in the fabric of from about 212° F. to about 400° F. to provide thermal shrinkage in the width of the fabric and then heat setting the fabric.

3. A method of making papermaker's felts containing a substantial portion of continuous filament synthetic heat retractable yarns comprising mechanically interlooping and snarling filaments of continuous multiple filament synthetic yarns to substantially increase the yarn denier and bulk, and weaving a felt-like fabric employing said mechanically bulked yarn in the filling, placing the woven fabric under longitudinal tension, heating the tensioned fabric to establish a temperature in the fabric of from about 212° F. to about 400° F. to provide thermal shrinkage in the width of the fabric and then heat setting the fabric.

4. A method of making papermaker's felts containing a substantial portion of continuous filament synthetic heat retractable yarns comprising mechanically interlooping and snarling filaments of continuous multiple filament synthetic yarns to substantially increase the yarn denier and bulk, and weaving a felt-like fabric, employing said mechanically bulked yarn in the warp and filling, placing the woven fabric under longitudinal tension, heating the tensioned fabric to establish a temperature in the fabric of from about 212° F. to about 400° F. to provide thermal shrinkage in the width of the fabric and then heat setting the fabric.

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