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BLANKET FOR USE IN AUTOMATIC SCREEN PRINTING PROCESSES

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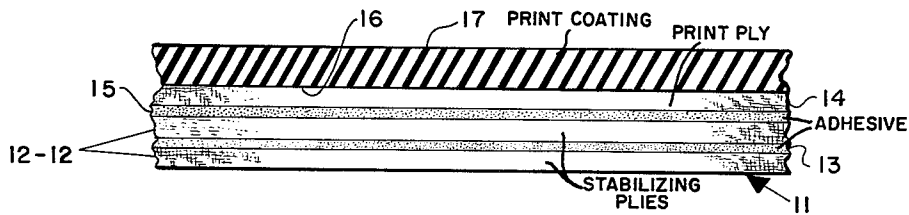


Fig. 1

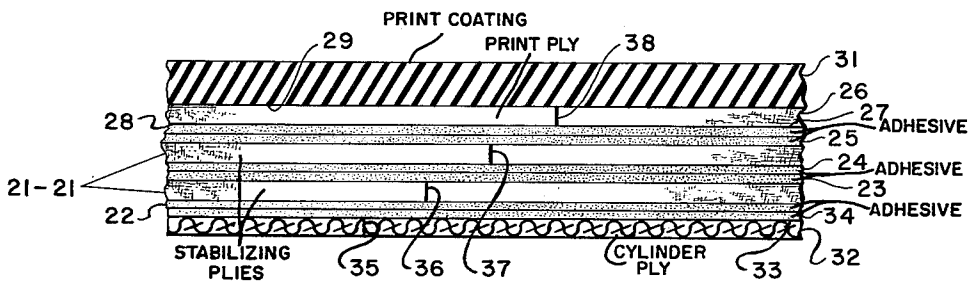


Fig. 2

1

2

3,203,848

BLANKET FOR USE IN AUTOMATIC SCREEN PRINTING PROCESSES

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This invention relates to textile print blankets, and particularly to blankets suitable for use in automatic screen printing processes.

Screen printing offers many advantages over the more conventional roller printing methods. It is less limiting as to the size of design and number of colors which may be used, gives a better bloom of color in the fabric, requires less expensive machinery and less time to change from one pattern to another. It is, therefore, particularly attractive from an economic point of view for printing low yardage runs of material, and also makes possible the use of large and complicated patterns.

Screen printing has long been practiced as a manual operation. Only in recent years have automatic processes and machinery come into use. In the automatic screen printing processes which have been developed, the fabric travels on an endless blanket or conveyor to which it is secured by an adhesive. The blanket, which travels across a printing table, is stretched around a drive roll and a take-up roll positioned at opposite ends of the table. The surface of the blanket is covered by an adhesive in advance of the point where the fabric to be printed is fed onto the blanket. The blanket is then advanced by the drive roll until the fabric is in printing position under the first screen, and is stopped in this position. The printing cycle consists in lowering the screen, applying dye to the fabric through the screen, raising the screen and again advancing the conveyor and the fabric to its position under the next screen. After the fabric has traveled the entire length of the table, it is removed from the blanket and is wound up on a separate take-up roll, while the blanket is washed and fresh adhesive is applied to it as it travels back to the starting point of the process.

The success of the screen printing process depends on accuracy of register of the design already printed with each new screen which transfers another portion of the design. Automatic screen printing machines have been perfected to such a point that a high degree of accuracy in register of the pattern, i.e. not more than 0.004 inch deviation, is possible. Development of screen printing blankets for this highly demanding use has not, however, kept pace with improvement of the machinery. The conventional textile print blankets which are made by spreading rubber cement on a number of plies of strong, uniform fabric and curing the assembled plies in a belting press to give a strong integral laminated structure, do not have sufficient dimensional stability to resist elongation under the intermittently applied force which pulls the blanket from one printing station to the next. As a consequence, when these blankets are used in automatic screen printing, the register gradually becomes less and less accurate, lines are blurred and fuzzy and the pattern goes "out of fit." Various complex electronic, magnetic and mechanical devices have been developed to correct for blanket stretch and ensure correct placement of the design under each new screen. These devices are expensive as well as complicated, however, and the necessity for using them to a large extent offsets the inherent advantages of the screen printing process.

It is an object of my invention, therefore, to produce a dimensionally stable textile print blanket for use in automatic screen printing processes. A further object

is to produce a blanket of laminated woven fabric and rubber construction which has enough dimensional stability to resist stretching under intermittently applied loads over a long period of time. Finally, it is an object of my invention to produce a dimensionally stable blanket which at the same time has a flat, even printing surface, is resistant to the action of pigment vehicles and wash solvents and may be readily cleaned of the adhesives which are used to secure the material to be printed to the blanket surface.

I have discovered that a dimensionally stable and otherwise highly satisfactory textile print blanket for use in automatic screen printing may be made by combining a strong, uniform woven textile fabric having a very low extensibility under load with a print ply of a relatively stretchy material. The screen printing blanket of my invention has as its stabilizing base one or more plies of a strong, uniform woven textile fabric which exhibits an extensibility under load of not more than about 10 percent as determined by the extensibility test hereinafter described. The stabilizing base is bonded to a print layer consisting of one or more plies of a material which has an extensibility under load at least twice that of the material used for the plies of the stabilizing base. If extra lateral stiffness is desired, a cylinder ply of the stretchable material may be bonded to the lower surface of the stabilizing base. The several plies of the blanket are bonded together by interply layers of an elastomeric adhesive, and the print ply is coated with a layer of a tough solvent-resistant elastomer.

The print blanket of my invention has a very low extensibility in use, both the initial elongation under load and the additional stretch or "creep" of the blanket due to intermittent application of load over a long period of time being substantially less than that of conventional textile print blankets. Reducing the extensibility of the blanket as a whole is not in itself, however, sufficient to produce a workable blanket for use with automatic screen printing machinery. I have discovered that, due to the longer arc described by the outside of the blanket compared with the inside as the blanket is bent around the rolls of the automatic screen printing press, the top or print layer may not be made of the same inextensible material as the stabilizing base portion of the blanket. The print layer must be capable of a greater degree of stretch in order to adjust itself to the necessary extra length without undue strain on the fabric. I have found that in general the print plies must have at least about twice the extensibility of the inner or stabilizing plies in order to avoid serious strain on the print plies and the interply bonds, with the resulting distortion of the print surface or structural failure of the blanket. My invention consists, therefore, in the combination of an inner stabilizing base formed of one or more plies of inextensible material with a print layer of relatively stretchy material, all bonded together by layers of elastomeric material and provided with a smooth, tough resistant print coating.

My invention will be more fully understood by reference to the accompanying drawing, in which FIGURE 1 is a cross section of a portion of a finished, or cured, blanket of three ply construction and FIGURE 2 is a cross section of the splice area of a four ply blanket prior to the press curing step.

In FIGURE 1, stabilizing base 11 is made up of stabilizing plies 12, 12 of low extensibility woven textile material bonded together by adhesive layer 13. Print ply 14 is bonded to stabilizing base 11 by adhesive layer 15 and is coated on its upper surface 16 with print coating 17.

FIGURE 2 shows the various plies of a blanket assembled in the well-known "sandwich" construction, be-

fore the blanket has been cured under pressure to unite the plies into a single, integral construction. Stabilizing plies 21, 21 are coated on both sides with adhesive coatings 22, 23, 24, 25. Print ply 26 is coated on its lower side 27 with adhesive coating 28 and on its upper, or exposed surface 29 with print coating 31. Cylinder ply 32 is coated on its upper surface 33 with adhesive coating 34. 35 denotes the splice in cylinder ply 32; 36 is the splice in lower stabilizing ply 21; 37 is the splice in upper stabilizing ply 21; and 38 is the splice in print ply 26.

The woven textile fabric used in my improved blanket may be selected from a number of different types of cotton, linen or synthetic fiber materials, so long as the fabric chosen has the required uniformity of weave and the strength necessary for the production of textile print blankets, together with the degree of extensibility necessary for its particular function in the screen printing blanket of my invention. I may use, as the stabilizing plies of the blanket of my invention, duck, canvas or similar material, or any fabric which has strong, inextensible warp threads and a relatively light, weak fill. One particularly useful material is a fine cotton duck with a 57 x 57 thread count, weighing 6 oz. per square yard, and having a tensile strength of about 140 pounds per inch of width of the material. This material is prestretched under load to its maximum elongation before using, in order to make the fabric substantially inextensible. It will sometimes be referred to hereinafter as "prestretched duck." Another material which may be used for the stabilizing plies is a cotton duck with a thread count of 49 in the warp and 30 in the fill, weighing 12.8 oz. per square yard and having a tensile strength of about 300 pounds per inch of width of the material. The warp threads of this material are particularly strong and inextensible, and impart to the fabric the necessary dimensional stability without prestretching. This material will sometimes be referred to hereinafter as "low stretch duck." The print and cylinder plies may be made of duck or twill fabric, or any other textile material in which the warp threads are inherently relatively extensible or have been subjected by the nature of the fabric weave to a substantial degree of crimping. Cotton duck has proved to be a particularly useful fabric for the print and cylinder plies of the blanket of my invention. I may use, for example, a lightweight duck having a thread count of 55 in the warp and 33 in the fill, weighing 10 oz. per square yard and having a tensile strength of about 116 pounds per inch of width. Alternatively, I may use a duck having a thread count of 65 in the warp and 56 in the fill, weighing 9 oz. per square yard and having a tensile strength of about 100 pounds per inch of width. These fabrics, which have a relatively high degree of extensibility under load, will sometimes be referred to hereinafter as "high stretch duck" fabrics.

The degree of extensibility under load has been found to be the most critical characteristic of the fabrics used in the various plies of my improved blanket construction, and to determine, in fact, whether the blanket can be used successfully in automatic screen printing. Since 60 pounds per inch of width is the maximum load to which the automatic screen print blankets will ordinarily be subjected in use, the extensibility of a fabric under the 60 pound load gives an excellent indication of the suitability of the fabric for printing blanket use. The degree of extensibility under a 60 pound load, calculated as the percentage of the original length of the sample, may be determined by the following method, which I have designated as the "Fabric Elongation Test."

FABRIC ELONGATION TEST

Samples of fabric six by one inches in size were clamped between the jaws of an Instron tensile tester, with a gauge length of three inches between the jaws. The jaws were then moved apart at a speed of one inch per minute, and

the loads applied and distance of travel of the jaws were recorded on the chart of the instrument. In elongation of the fabric at 60 pounds load per inch of width of the fabric could then be calculated from the data recorded on the chart. The "prestretched duck" fabric described above was found to have an extensibility under a 60 pound load of 8.5 percent, while the extensibility of the "low stretch duck" fabric was 8.0 percent. The two "high stretch duck" fabrics were found to have extensibilities of 20.0 and 31.5 percent respectively.

I have found, as stated above, that the woven textile material which is to be used in the stabilizing base portion of my improved blanket must have a very low extensibility, i.e. it must stretch by not more than about 10 percent of its length when tested by the Fabric Elongation Test described above. The print ply material must be a much more extensible fabric, and must have an extensibility at least twice as large as that of the fabric to be used in the stabilizing base. The cylinder ply, if used, must also be made of a material which is capable of stretching at least twice as much as the fabric of the stabilizing base.

The finished blanket in which the textile plies are bonded together by layers of adhesive into a single unitary structure will, of course, have a very much lower elongation under load than will the raw fabrics. There appears to be, however, a very real correlation between the elongation of the raw fabric plies and the performance of the finished blanket, and the limits of extensibility of the fabrics set forth above appear to be the major factors which determine the suitability of the blanket for use in the automatic screen printing process.

The fabric plies are bonded together by interply layers of an elastomeric material, which must have sufficient strength and adhesiveness to produce strong, lasting bonds between the plies, and should preferably be resistant to attack by the particular solvents which may be present in the dyes or washes used in the printing process. The adhesives employed for this purpose are those conventionally used in the manufacture of textile print blankets, as disclosed, for example, in U.S. Patents Nos. 2,723,932 and 2,963,393. The adhesives may be based either on water dispersions or solvent solutions of the elastomeric material, which may be, for example, neoprene, butadiene-acrylonitrile copolymers, butadiene-styrene copolymers, natural rubber and the like. The following composition is an example of a typical, curable interply cement which may be used in the construction of my improved blankets.

Example 1.—Preparation of a typical interply cement

	Parts by weight
Neoprene latex	415
Polyoxyethylated fatty alcohol (wetting agent—"Emulphor" ON)	2.1
Sodium silicate	3.3
Ball mill batch	112
Methylcellulose	8.3
Dimethylpolysiloxane (anti-foam agent)	0.1
Water	777

This composition is prepared in the normal manner in the liquid phase. The ball mill batch referred to is prepared by mixing the following ingredients in a ball mill according to conventional practice until a smooth dispersion results:

	Parts by weight
Zinc oxide	90
Phenyl-β-naphthylamine (antioxidant)	36
Benzothiazyl disulfide (retarder)	18
Calcium carbonate	90
Iron oxide, pigment grade	4.5
Polymerized sodium salts of alkyl naphthalene sulfonic acid (wetting agent—"Daxad" 11)	4.5
Bentonite clay	2.5
Water	195.5

The upper or print ply of the blanket is finished according to conventional practice in the print blanket art, with a smooth, tough impervious coating of an elastomeric material which is resistant to attack by the solvents used in the dyes and washes, and which is strong enough to withstand repeated washing throughout the printing process. The print coating is applied in conventional fashion as shown in U.S. Patent No. 2,723,932, by spreading on the print ply a liquid coating composition which may be based on either a water dispersion or a solvent solution of an elastomeric material such as, for example, butadiene-acrylonitrile copolymers, neoprene, polysulfides, polyurethanes and the like. The following composition is an example of a typical coating cement which may be used to form the print coating on my improved blankets.

Example II.—Preparation of a typical coating cement

Butadiene-acrylonitrile rubber (35 percent acrylonitrile) -----	295
Zinc oxide -----	15
β,β -naphthyl-p-phenylenediamine (antioxidant) --	6
Sulphur -----	6
Cumarone-indene resin -----	60
Channel black -----	146
Paraffin wax -----	9
Stearic acid -----	3
N-cyclohexyl-2-benzothiazole sulfenamide (accelerator) -----	37
Propylene dichloride -----	2500

(The various dry ingredients are mixed together in an internal mixer to form a homogeneous compounded rubber batch, which is then dissolved in the propylene dichloride.)

Example III.—Example of blanket construction

The interply cement of Example I is applied by knife coating to both sides of the above-described prestretched duck fabric having an extensibility of 8.5 percent under a load of 60 pounds per inch of width, to a thickness sufficient to deposit about 0.15 pound of dry solids on each square yard of the fabric. Another length of the same low extensibility fabric is coated with the interply cement on one side only, to a thickness sufficient to deposit about 0.15 pound of dry solids on each square yard of fabric. These coated fabrics are referred to as the "inner ply material."

A fine cotton duck weighing 9 oz. per square yard and having a thread count of 65 in the warp and 56 in the fill, a tensile strength of about 100 pounds per inch of width of the fabric and an extensibility of 31.5 percent under a load of 60 pounds per inch, is coated in a similar manner on one side with the interply cement to deposit an amount of about 0.15 pound of dry solids on each square yard of the fabric and on the other side with the coating cement of Example II, to deposit about 1.0 pound of dry solids on each square yard of the material. The coated duck is referred to as the "print ply material."

The coated plies are then dried, cut to the desired blanket length and stacked up in sandwich fashion on an assembly table, first the single-coated inner ply with its uncoated side on the table, then the double-coated inner ply, and finally the print ply, with the cement coating uppermost. The entire assembly is then cured in stepwise fashion in a vulcanizing press, each section being cured for 12 minutes at a temperature of 325° F. and a platen pressure of about 500 pounds per square inch. Material is left uncured at both ends of the blanket so that, as a last step in the curing process, the ends of the blanket can be spliced together to form an endless loop. The splices in the various plies are arranged in staggered or stepwise fashion, in accordance with the usual practice in manufacturing textile print blankets so that in each case the overlying ply covers the joint in the ply beneath. The splices may be either transverse or

bias cut butt joints, or preferably the "saw-toothed" joint disclosed in U.S. patent to Merrill No. 2,547,220, dated April 3, 1951. The finished blanket is then removed from the vulcanizing press and trimmed to the desired width.

In some cases it is necessary to impart additional lateral stiffness to the blanket, in order to prevent the blanket from wrinkling or curling when a particularly wide pattern is printed. This may be done by providing a cylinder ply which is attached to the lower stabilizing ply, as shown in FIGURE 2. I have found that for best results the cylinder ply should also be made of the stretchable print ply fabric, which is coated on one side only with the interply cement. In this case, of course, the lower stabilizing ply would be coated on both sides with interply cement.

The amount of interply cement may be varied as desired, in order to give adequate adhesion between the various plies. With the particular interply cement composition shown above, I prefer to provide from about 0.30 pound to about 0.8 pound per square yard of dry solids between each two adjacent layers of woven textile fabric. The thickness of the print coating may likewise be varied to some extent, from about 0.7 pound to about 2.0 pounds of dry solids per square yard ordinarily being sufficient to provide a strong, smooth, permanent printing surface. The temperature, pressure and dwell time in the vulcanizing press may also be varied, according to principles which are well known in rubber technology, to cure the particular elastomers used and to form the several plies into a single strong unitary structure.

Following the procedure described above, I have assembled a number of different blankets in which fabrics of varying extensibilities were used for the inner, print and cylinder plies. These blankets were tested in the laboratory and in some cases in actual service on automatic screen printing presses. Because of the length of time necessary for in-service tests, a relatively simple laboratory test has been developed for measuring the extensibility of the blankets under both long and short periods of stress. This test has been found to be extremely useful in predicting the elongation of the blanket under printing conditions and the resulting accuracy of register which can be obtained with any given blanket.

BLANKET ELONGATION TEST

An extension tester was constructed in which the material to be tested was held between two jaws, one of which was stationary and the other of which could be advanced or retracted by an adjusting nut. A Dillon strain gauge was connected to the stationary jaw to measure the load applied to the sample. An Ames micrometer gauge was positioned between the movable jaw and the adjusting nut, to measure the distance of travel of the movable jaw, i.e. the elongation of the sample under load. The instrument was calibrated by placing a piece of steel plate in the jaws and measuring the machine deflection in mils against loads which varied from one pound to 100 pounds in increments of 10 pounds. Since there was no machine deflection at a one pound load this was taken as the zero point of the instrument. The machine deflection data was used to correct test data on blanket samples, for deflection inherent in the machine itself.

Blanket samples measuring one inch by four and one-half inches were secured in the jaws by the short sides of the samples, and the jaws were adjusted at the zero point of the instrument. The load was then increased by retracting the movable jaw, and the immediate elongation of the sample in mils was measured for each 10 pound increment of load up to 100 pounds. The immediate elongation of the sample at a given load, expressed as percentage of the original length of the sample, is referred to as the "initial" or "dynamic" extension of the sample under that load.

The elongation of the sample under a constant load applied over a period of time was also measured. In this case, the sample was secured in the jaws and the movable jaw was retracted until the desired load was registered on the Dillon strain gauge. This setting was maintained until the resulting elongation of the sample caused the load on the sample to decrease. The distance between the jaws was then readjusted to place the sample under the original load, and this process was continued until the sample showed no more elongation under the particular load applied. It was found that, for each blanket sample tested, the elongation with time, or "creep" of the sample, under uniform load approached a limiting value which was characteristic of the particular sample. This elongation limit is reported as the creep of the sample at a given load, expressed as percentage of the original length of the sample.

The elongation of various blanket constructions, as measured by the Blanket Elongation Test, as well as the performance of the blankets in actual service are reported in Table I below. The elongation figures are based on a load of 50 pounds per inch of width of the blanket sample.

print ply when the blanket was bent around the rolls of the machine, however, due to the fact that the arc formed by the outside of the blanket was greater than that formed by the inside. In this case, the additional strain on the inextensible material used resulted in the rupture of the adhesive bond between the print ply and the print coating, rendering the blanket totally unfit for service in the screen printing process. The additional strain imposed in this fashion may also result at times in the formation of puckers or wrinkles in the blanket, which also make the blanket unfit for use.

I have found that the print ply must be made of a relatively stretchy material, as shown in blankets 1, 8 and 9, in order to allow the print ply to stretch by the necessary additional amount as the blanket is bent around the rolls, and still present a flat and undamaged surface for printing. Blankets which incorporate print plies made of a material having twice the extensibility of the fabric of the stabilizing plies will give satisfactory results in printing. I prefer, however, to use as the material of the print ply a fabric which has an elongation three or four times that of the stabilizing base material, since there is less strain on such a material as the blanket is bent around the

TABLE I

Blanket No.	Stabilizing base			Print layer		Cylinder layer		Initial extension of blanket, percent	Blanket creep, percent	Blanket performance	
	No. plies	Fabric	Extensibility	Fabric	Extensibility	Fabric	Extensibility			Accuracy of register	Other comments
1	2	Low stretch duck.	8.0	High stretch duck.	31.5			1.5	0.55	Excellent	Satisfactory but not stiff enough for wide patterns.
2	2	High stretch duck.	20.0	do	31.5			2.5	0.83	Poor	Large amount of stretch in use.
3	1	do	31.5	do	31.5	High stretch duck.	31.5	5.6	1.7		
4	2	Prestretched duck.	8.5	Prestretched duck.	8.5	Prestretched duck.	8.5	1.0	0.25	Excellent	Coating "checked" off print ply when blanket bent around cylinder.
5	2	High stretch duck.	20.0	High stretch duck.	31.5			3.6	1.2		
6	2	do	20.0	do	20.0	High stretch duck.	20.0	3.6	1.2	Poor	Large amount of stretch in use.
7	3	Prestretched duck.	8.5	do	31.5			0.95	0.20		
8	1	do	8.5	do	31.5	High stretch duck.	31.5	1.8	0.5	Good	Blanket split apart at splice during use.
9	2	Low stretch duck.	8.0	do	31.5	do	31.5	1.3	0.3	Excellent	Good lateral stiffness.

It will be seen by reference Table I that blanket numbers 1, 4, 8 and 9, which had inner plies of very low extensibility, gave most satisfactory accuracy of register in service. It has been possible, in fact, to achieve an accuracy of as little as 0.0078 inch total deviation in 25 repeats using blankets of this construction, or in other words, an accuracy of 0.0003 inch for each repeat of the pattern. When the extensibility of the inner ply fabric exceeded about 10 percent, however, as measured by the Fabric Elongation Test, the blankets themselves had too high an extensibility and gave unsatisfactory register of the design in printing.

It has been found that the initial extension figures as determined by the Blanket Elongation Test can be used to predict the extensibility of the blanket in service, and the blankets which exhibit more than about 2.0 percent initial elongation under a 50 pound per inch load will give unsatisfactory registry of the design. It has been found, likewise, that blankets must exhibit not more than about 0.65 percent creep under a uniform load of 50 pounds per inch of width, in order to make possible the necessary accuracy of register during use.

Blanket number 4 is of particular interest. In this case, the low extensibility fabric was used for all four plies of the blanket, giving an exceptionally low initial extension and creep under load, and excellent accuracy of register in printing service. Additional strain was imposed on the

rolls, and the blanket will be expected to give longer service as a result. There is apparently no upper limit to the amount of elongation which may be present in the print ply as long as the fabric has the necessary strength and uniformity to make it suitable for use in textile print blankets.

The provision of a cylinder ply between the stabilizing base of the blanket and the rolls of the printing press constitutes a preferred form of my invention. Such a ply is particularly helpful when the basic blanket lacks the lateral stiffness necessary to prevent curling of the edges and formation of lateral folds or wrinkles when especially wide patterns are printed. The cylinder ply should preferably be made of the stretchable material with an elongation at least twice that of the stabilizer plies, since this material is also able to be compressed to a shorter length as the blanket travels around the roll and then to resume its normal length in the straight portions of its travel path. This property enables the blanket to fit snugly to the rolls during the printing process and reduces the chance of the formation of wrinkles which may become permanent and cause the pattern to misprint.

Blanket number 8, which had a single ply of low extensibility material as its stabilizing base, gave very satisfactory performance immediately after it was put on the machine. The accuracy of register was good. The splice area of the single stabilizing ply, however, proved not to

be strong enough to withstand the repeated and continuous application of tension to the blanket. As a result, the entire splice area tended to open up, the adhesive worked into the open crack, and the blanket became unsuitable for service. In order to obtain the strength needed in blankets which are subjected to the constant heavy loads encountered in screen printing, and with the type of splice currently used in manufacturing blankets, it has been found necessary to use at least two plies of the low extensibility fabric in the stabilizing base. When the ends of the blanket are spliced together, as described above, one stabilizing ply covers the splice area of the other, thus imparting enough additional strength to the splice area of the blanket so that there is no tendency for the splices to open even after long use of the blanket. In general, I prefer to use two plies of low extensibility fabric in the stabilizing base of my improved blanket, since this construction results in a dependable, strong blanket without the excessive stiffness which may be encountered when as many as three stabilizing plies are used. The selection of the proper number of plies, however, depends on the general properties of the fabrics used, as well as on the stiffness and thickness desired in the particular blanket which is being constructed.

I claim:

1. A textile print blanket which includes
 - a stabilizing base comprising two plies of a woven cotton duck material which has an extensibility of about 8.0 percent under a load of 60 pounds per inch

of width of the material, said plies being bonded together by a layer of elastomeric material,

a stretchable intermediate print ply of a woven cotton duck material which has an extensibility of about 30 percent under a load of 60 pounds per inch of width of the material, said print ply being adhesively secured to the said stabilizing base by a layer of elastomeric material,

and as a print surface, a coating of elastomeric material on the exposed upper surface of the said print ply.

2. The textile print blanket of claim 1 which includes a cylinder ply of a woven cotton duck material which has an extensibility of about 30 percent under a load of 60 pounds per inch of width of the material, said cylinder ply being adhesively secured to the lower, exposed face of the stabilizing base by a layer of elastomeric material.

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