FABRIC EFFECT FOR FIBROUS GLASS FABRICS

Original Filed Sept. 8, 1966 4 Sheets-Sheet 1

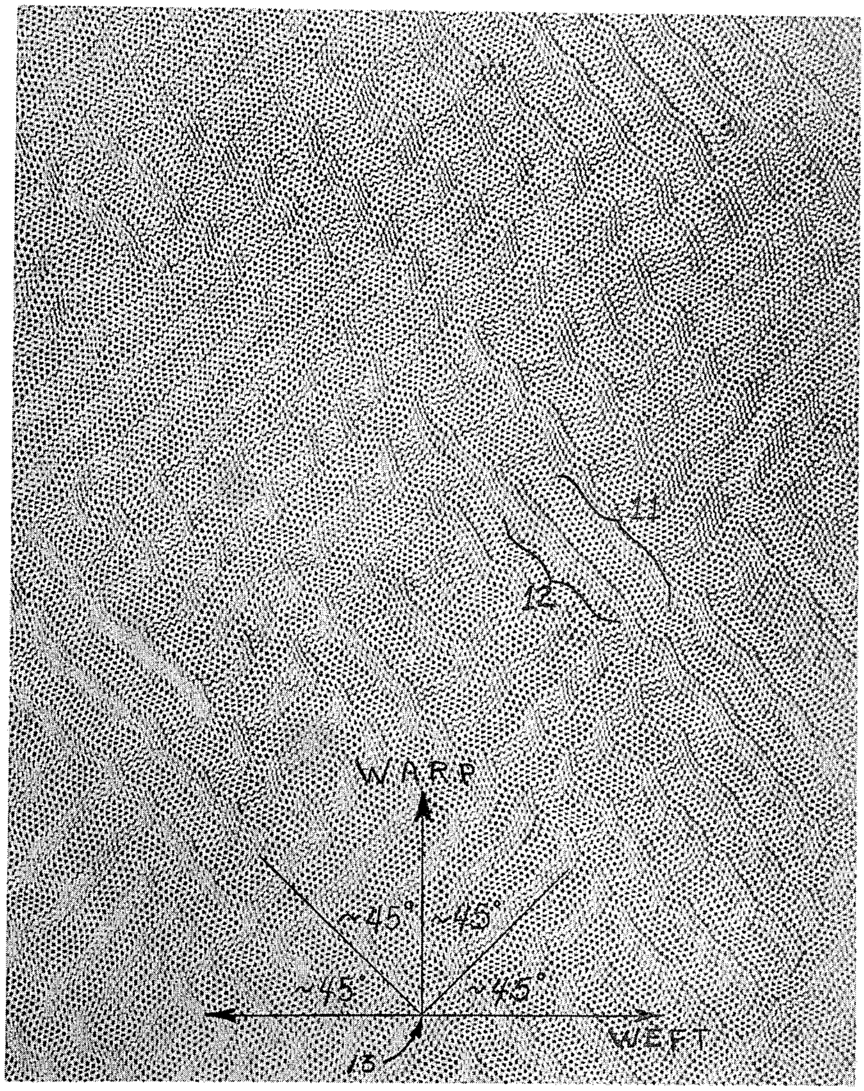

Fig. 1

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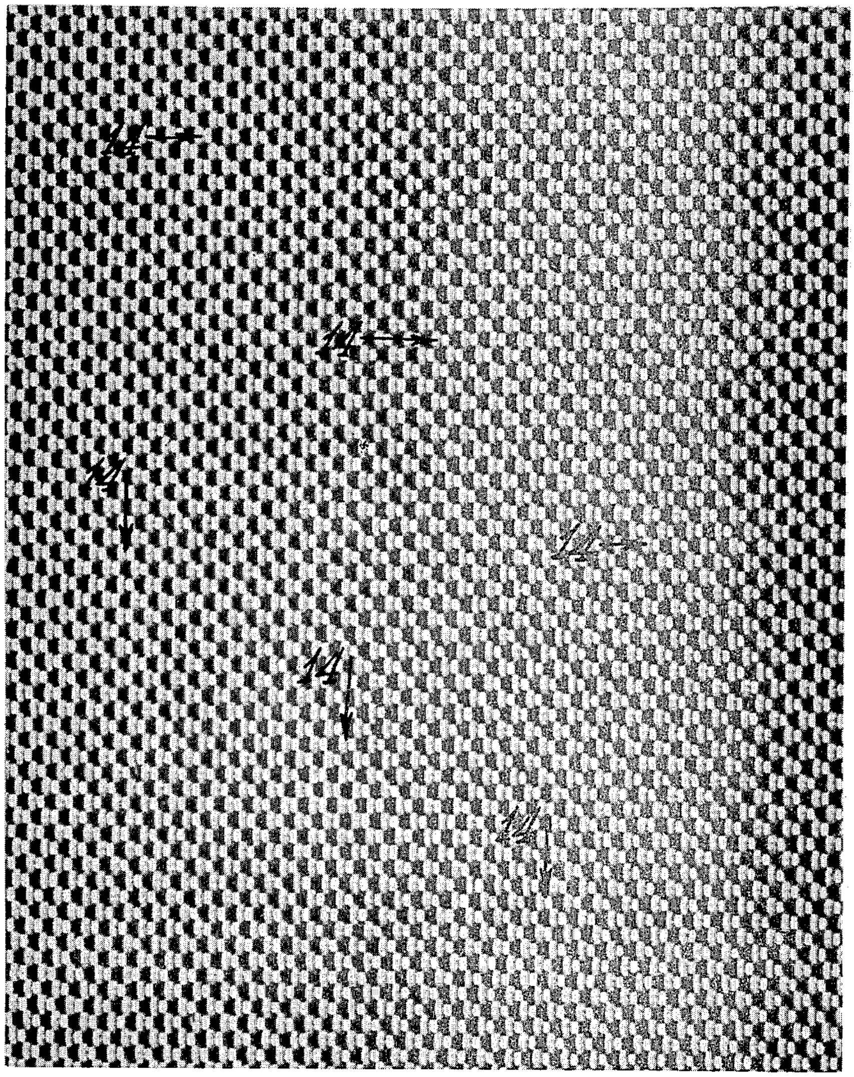

Fig. 2

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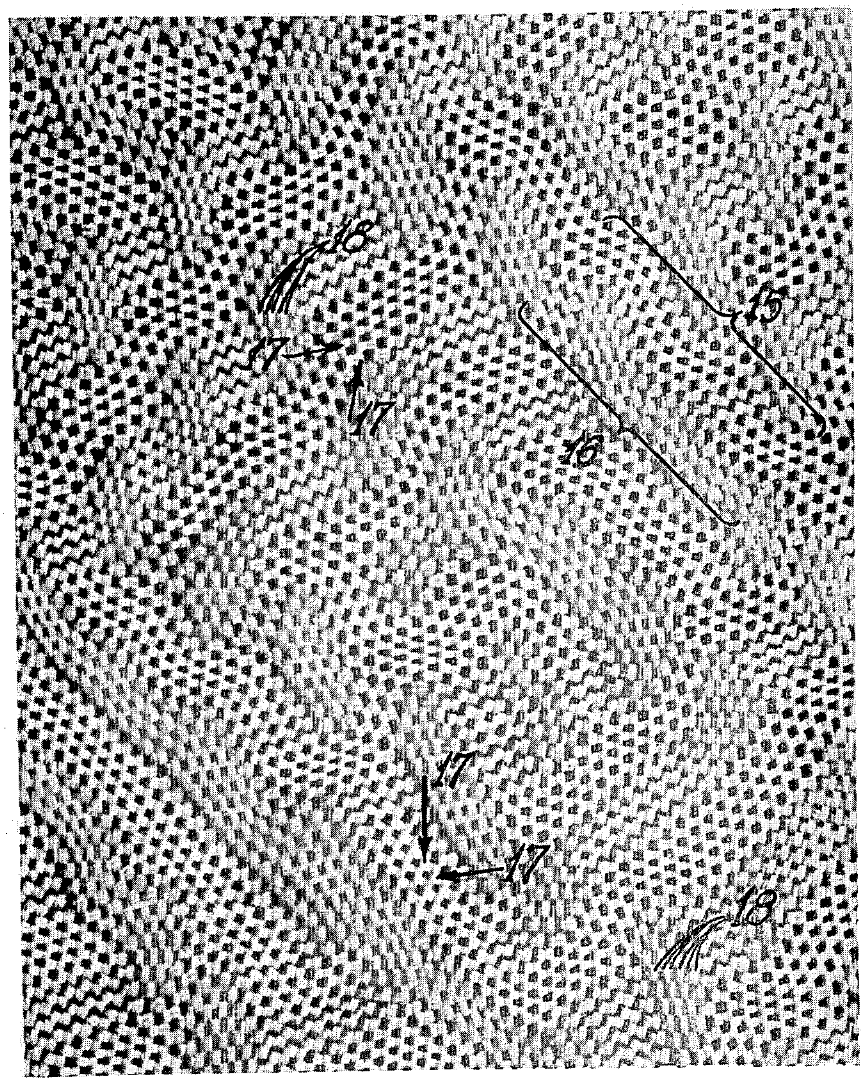

Fig. 3

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FABRIC EFFECT FOR FIBROUS GLASS FABRICS

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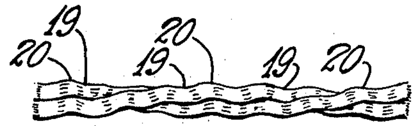

Fig. 4

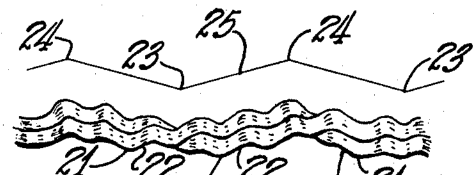

Fig. 5

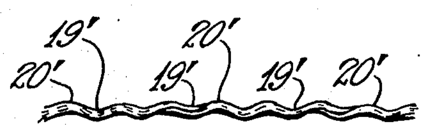

Fig. 6

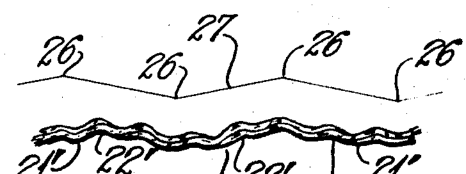

Fig. 7

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3,720,571

FABRIC EFFECT FOR FIBROUS GLASS FABRICS

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Original application Sept. 8, 1966, Ser. No. 578,430, now Patent No. 3,571,871. Divided and this application Mar. 19, 1971, Ser. No. 126,093
Int. Cl. D03d 3/00
U.S. Cl. 161—73 4 Claims

ABSTRACT OF THE DISCLOSURE

Fibrous glass fabric having pseudo-embossed effects, comprising warp and weft yarns lying in laterally and vertically randomly shifted, stress-relieved and compacted equilibrium configurations of the original weave pattern wherein the yarns were originally in a stressed condition due to their displacement from an essentially straight configuration into sinusoidal paths in the original weave pattern.

This is a divisional application of Ser. No. 578,430, filed Sept. 8, 1966, now U.S. Pat. No. 3,571,871.

The present invention relates to methods for imparting decorative weave effects and designs to fibrous glass fabrics in a post-weaving process and particularly to methods comprising the transformation of stresses existing in a given weave design to yield a uniform or non-random weave effect.

To date, weave effects other than post-weaving decoration such as dyeing, screen-printing and the like, have been achieved either by weave design or by post-weaving treatments other than finishing. Typical of such weave designs are ribbed or corded fabrics such as piques. Bedford cords, corduroy, or the like; crepe constructions which rely upon the tensions inherent in highly twisted yarns; and pile fabrics such as velvet, velour, terrycloth, and friezes which employ projecting loops or severed loops. Post-weaving fabric effects consist of selective shrinkage of a portion of the yarns employed in a fabric, e.g. seersucker, the thermal treatment of combination yarns having different coefficients of expansion or contraction, or the chemical treatment or embossing of resin treated fabrics, e.g. plisse and blister crepes.

While both of the foregoing groups of methods of achieving decorative effects are operable, each type is hampered by certain impediments. Unconventional weaving operations used to produce unique weave effects such as Jacquard figures require modified or special looms and increase weaving costs. Additional expense, limited utility of equipment, and the necessity for the use of auxiliary materials such as resins or resinous yarns, often make post-weaving treatments prohibitive.

All of the foregoing impediments are multiplied in the case of fibrous glass fabrics. In the case of novelty weaves, existing looms are designed for the processing of yarns having conventional tension and abrasion characteristics. While the tensions of fibrous glass yarns are partially controllable by the selection and metered application of different size compositions, the tension characteristics of sized fibrous glass yarns vary considerably from the corresponding characteristics of natural and other synthetic yarns. In addition, glass fibers are mutually abrasive; prolonged contact of the moving yarn with guide eyes and contact points tends to yield quantities of fuzz or fly with attendant decreases in the strengths of the yarn. Consequently, fibrous glass yarns are not immediately adaptable to conventional weaving techniques, let alone to more complex weaving operations.

The unique tension characteristics and tendency to produce fuzz in weaving operations are results of the combined stiffness and resiliency of glass fibers and fibrous glass yarns. For example, fibrous glass yarns have a stiffness of 322 grams per denier, as compared with values of 4 grams per denier for wool, 11 for rayon, 6 for acetate, 18 for nylon, 10 for acrylic and 21 for polyester yarns. This unusual stiffness is accompanied by an elastic recovery of 100%. As a consequence of such properties in fabrics woven from glass yarns, the yarns are highly stressed by the displacement of the individual glass filaments and the yarn itself by the weave pattern. Such stresses are evidenced by the ease with which a fibrous glass fabric may be unraveled. To relieve these stresses, fibrous glass fabrics are subjected to a weave setting treatment in which the fabric is heated to a temperature just in excess of the softening point of the glass fibers. Upon cooling, the yarns are permanently set in the pattern of the weave and consequently relieved of weave induced stresses.

Again because of the stiffness of fibrous glass yarns, they have a critical radius of curvature, correlated to the actual diameter of the fibers, which may not be exceeded without breaking the fibers. Such a limitation prohibits the use of weave designs which entail the bending of the yarns through small radii. In addition, fabric affects achieved by the use of combinations or blends of glass fibers with other fibers or the use of fabric coating materials may dilute the desirable properties of strength, translucency, ease of cleaning, wrinkle recoverability, and dimensional stability which fibrous glass fabrics naturally possess. As a result of those properties which are unique to fibrous glass fabrics, and the increased costs of the use of complex weaving or post-weaving treatments, the use of fabrics in fibrous glass fabrics has been substantially restricted.

An object of the present invention is the provision of methods for imparting weave effects and fabric design to a fibrous glass fabric.

Another object is the provision of methods for imparting weave effects and fabric design to fibrous glass fabrics without using complex weaving operations, or special additional yarns, fibers or coatings to cause the effects.

A further object is the provision of fibrous glass fabrics possessing a weave effect and fabric design.

Other objects and advantages of the invention will be apparent from the following description.

Specifically, it has been found that the stresses inherent in a fibrous glass fabric may be employed to impart a new compacted state of equilibrium which results in a fabric design different from the original weave pattern, and capable of being permanently preserved in its new or modified form.

The process entails the random application of controlled force to the fabric, in which the force applied is in itself less than that required to physically shift the yarns within the weave pattern. Instead, the forces applied act both to relieve in some places the stresses induced in the yarns by the weave pattern, and to reinforce in other places those stresses thereby permitting and achieving, respectively, shifting of the yarns within the weave pattern to yield a new non-random pattern which is determined by the stresses inherent in the yarns in the original weave pattern. That is, the stiffness and resiliency of the fibrous glass yarns resist the displacement of the yarns in the weave pattern, and these forces, latent in the yarns as stressed in the weave pattern, may be rendered operative by relief or reinforcement to yield a compacted weave effect and pseudo-embossed fabric design. The means of rendering these forces operative is the application of outside forces which are capable of overcoming, neutralizing, or reinforcing the forces already present in the yarns in a weave pattern, but said outside forces being inadequate by themselves to shift the yarns physically within the weave pattern. However, the sum of the forces induced in the yarns by the weave pattern and the outside forces placed on the yarns by this method is sufficient to shift yarns within the limits of weave pattern. As a consequence of the release, neutralization, and reinforcement of such forces and the shifting of the yarns, said yarns seek the path of least resistance to assume a new configuration. The non-random character of the new weave pattern is the result of the fact that the original weave pattern produced non-random or patterned stresses in the yarns, and the reflexing actions of the yarns upon the release of those restrictive forces also act in a non-random fashion. In the case of glass fabrics, this new effect may then be permanently retained by means of subjecting the fabric to a temperature in excess of the softening point of the glass fibers.

In the accompanying figures, forming a part of this specification,

FIG. 1 is a top view of a fibrous glass fabric having the pseudo-embossed fabric effect, and viewed perpendicular to the plane of the original fabric weave,

FIG. 2 is a greatly enlarged top view of a fibrous glass fabric before being treated in accordance with the present invention, again viewed perpendicular to the plane of the fabric weave,

FIG. 3 is a greatly enlarged top view of the same fibrous glass fabric illustrated in FIG. 2, but after the fabric was treated in accordance with the present invention, and again viewed perpendicular to the plane of the original fabric weave,

FIG. 4 is a greatly enlarged top view of a single yarn from the fabric of FIG. 2, viewed perpendicular to the plane of the fabric weave,

FIG. 5 is a greatly enlarged top view of a single yarn from the fabric of FIG. 3, viewed perpendicular to the plane of the original fabric weave,

FIG. 6 is a greatly enlarged side view of a single yarn from the fabric of FIG. 2, viewed in the plane of the fabric weave—i.e. rotated 90° from the view in FIG. 4; and,

FIG. 7 is a greatly enlarged side view of a single yarn from the fabric of FIG. 3, viewed in the plane of the fabric weave—i.e. rotated 90° from the view in FIG. 5.

The total fabric effect is shown in FIG. 1. The zones of differing reflectivity **11** and **12** are obvious, and the angles **13** made by those zones with the original warp and weft directions are also shown.

FIG. 2, a greatly enlarged view of a fabric, shows in detail the relationship of the yarns before the fabric is treated in accordance with the present invention. The uniformly equal areas of exposed yarn **14** are obvious here, and may be compared with the unequal areas **17** shown in FIG. 3. FIG. 3, an equally enlarged view of a fabric, shows in detail the relationship of the yarns after treatment in accordance with the present invention. This figure shows the zones of reflectivity **15** and **16** which are made up of larger exposed yarn areas **17** which are in turn caused by the local compaction **18** of the yarns in one direction. This figure also clearly show that both warp and weft yarns are similarly displaced in their equilibrium configurations.

FIG. 4 shows an individual two-strand yarn from the unprocessed fabric. This top view shows the highlighted areas **19** and **20** corresponding to the valleys and peaks, **19'** and **20'** in FIG. 6, in the sinusoidal displacement of the yarns in the original fabric weave.

FIG. 5 shows a corresponding yarn taken from a sample of the same fabric after having been treated in accordance with the present invention. The highlighted areas **21** and **22** corresponding to the sinusoidal valleys and peaks, **21'** and **22'** in FIG. 7, caused by the original fabric weave are shown, but, in addition, the yarn is distorted with various sinuous valleys **23** and peaks **24** in the plane of the fabric weave and in other planes, as schematically shown by line **25**. The major displacement here is in the plane of the fabric weave, but there is vertical displacement, shown in FIG. 7, which give the fabric a slight loft.

FIG. 6 shows a side view, within the plane of the fabric weave, of the single yarn shown in FIG. 4. Here the uniform, sinusoidal valleys **19'** and peaks **20'** are readily seen.

FIG. 7 shows a side view, within the fabric weave, of the single yarn shown in FIG. 5. The sinusoidal valleys **21'** and peaks **22'** corresponding to the highlighted areas **21** and **22** of FIG. 5 are obvious, but other sinuous displacements **26**, as schematically shown by line **27**, are also visible, some of which correspond to the displacements **23** and **24** of FIG. 5.

As an example of this effect, one may shift the weave of a fabric with fingernails or the point of a pencil. However, it is difficult to achieve a non-random or uniform effect by this means. Also, any effect which is derived is dispelled by the application of tension in the warp and fill directions. However, this illustration does show that a series of such shifts could rearrange the original weave pattern into a new fabric design.

It has been found desirable and expedient to apply a series of forces to a fabric with none of the individual, applied forces equaling the force required to shift the yarns within the weave pattern. The repeated application of such moderate forces randomly throughout the fabric allows the yarns to shift about locally within the limits of the weave pattern and compacts the weave pattern until a new equilibrium configuration is reached. Hence the random application of force is not detrimental when continued until every portion of the fabric has been exposed to such forces, and each yarn has reached the new equilibrium configuration. As the forces are randomly applied and stresses relieved in a given yarn, that yarn and adjacent yarns shift. Naturally, a given point upon a certain yarn may experience a number of shifts since the shifting of adjacent yarns will permit subsequent shifting of that point upon the yarn. In this fashion, the reflexive shifting of yarns throughout the entire fabric permits the realization of new and uniform equilibrium configurations of the weave pattern despite the non-uniform application of forces.

It should be noted that each weave design creates a distinct series of stresses which accordingly yield a distinct, uniform effect upon treatment in accordance with the present invention. It is also significant that the stresses existing in a given weave design, and the effect which may be realized by means of the present invention, may be modified or altered through the degree of twist imparted to the yarn or the use of plied yarns in the weaving of the fabric. For example, yarns in a fabric possess certain stresses as a result of their displacement by the weave pattern. However, additional stresses may be designed into the fabric by changing the amount of twist of the yarns or by plying the yarns before weaving. Then the counter-action of such stresses and forces applied by means of the present invention allows the reflective shifting of the yarns in even another mode. While the pattern of the effect differs for each type of weave, and its extent may be changed by corresponding changes in weaving tensions, yarn twist, or plied yarns, for example, it should be noted that for a given weave, the effect achieved is always reproducible.

It is significant that the effect is not locally isolated at random positions throughout the fabric, but it is a uniform result of shifts of all of the yarns within the weave pattern. For example, in a plain taffeta weave, the effect, since it is three dimensional, is most obviously seen in the sheen or reflectivity of the fabric. The sheen of fibrous glass fabric in a plain taffeta weave, before treatment in accordance with this invention, is quite uniform, since this fabric is essentially flat. In contrast, the same fabric when treated exhibits alternating zones of high and low reflectivity or sheen in the form of elongate strips which intersect the warp and fill directions at an angle of approximately 45 degrees. These zones of different degrees of sheen or reflectivity give the fabric a pseudo-embossed effect.

From the description of the invention and FIGS. 5 and 7 depicting the changes in individual yarns, it should be obvious that fabrics treated in accordance with the present invention undergo a reduction in their two major dimensions. The term shrinkage has not been employed due to the fact that glass yarns do not shrink in the ordinary sense of the word—that is, the individual fibrous glass yarns do not compact throughout their mass. The reduction is net length of the individual yarns is a result of the yarns assumption of a sinuous position in the new equilibrium configuration of the fabric. The sinuous position of the yarns also gives the fabric a slight loft, enhancing the pseudo-embossed effect.

While the process for achieving the described fabric effects may be defined as the repeated random application of forces adequate to counteract and relieve stresses inherent in the yarns in a weave pattern and thereby permit the yarns to reflexively shift to relieve stresses, but such forces inadequate to directly shift the yarns, there are various means of accomplishing this effect.

EXAMPLE I

For example, an adequate force may be applied to a fibrous glass plain weave fabric by subjecting the fabric, prior to weave setting, to a "cotton cycle" of approximately twenty minutes in a conventional household washing machine. The fabric treated in this manner contains a fabric design made by the yarns shifted in the weave pattern so that the new effect is uniformly achieved throughout the entire length and breadth of the fabric. The described effect is not easily removed by the application of tension in the warp, fill or bias directions or by distortion such as crumpling the fabric. In addition, the effect may be permanently set by heating the fabric to temperature just in excess of the softening point of the glass fibers. This can be accomplished by either a continuous or a batch process. Upon cooling, the yarns and fibers in the new configuration are essentially free of stresses and the new equilibrium weave effect is permanently set in the fabric. The fabric may then be finished, dyed, or printed in the conventional manner.

It should be noted that while moisture and moderate temperatures (100–180° F.) such as those experienced in a washing machine cycle, appear to facilitate the achievement of the fabric effect, neither is essential. Moisture or moderate temperatures may assist by softening any adhesion between the yarns at their crossover points which may result from the size composition which is usually applied to glass fibers just after their formation.

Also, the moisture may act as a lubricant to facilitate the slipping of the yarns one among the other within the bounds of the weave pattern. Note that in addition to the water or other liquid medium, a lubricant may be added specifically for the above purpose. With water, any soapy substance will work as a lubricant. With other media, other compatible lubricants must be chosen.

EXAMPLE II

The presence of moisture, lubricants, or heat is not necessary as evidenced by the fact that the same effect may be partially achieved by the action of a conventional textile swing frame. The action of the swing frame is strictly mechanical. The presence of liquid lubricants alone does not accelerate the achievement of the effect in the absence of correspondingly accelerated applied force. This was again demonstrated by placing a fibrous glass fabric in a "rope soaper" which repetitively immersed and withdrew the fabric from a hot water bath. The desired fabric effect was realized only after prolonged treatment in that maner. Note particularly that the agitation and turbulence provided by a rope soaper is mild compared to that provided by a household washing machine. It is

the repeated random application of moderate forces to the loosely suspended fabric which achieves the desired effect in any of these methods.

EXAMPLE III

The effect is also achieved by loosely suspending the fabric and subjecting it to a jet of liquid or gas. A series of such jets is arranged in any desired pattern, so that a corresponding pattern of the pseudo-embossed effect is processed into the fabric. With this system the pressure used in the fluid jets and the time of treatment varies the extent of the achieved effect.

EXAMPLE IV

Another method of processing fibrous glass fabrics with a definite pattern of the pseudo-embossed effect is to use a stencil-like die which allows treatment of the desired areas, and essentially immobilizes the areas of the fabric which are not to be treated. Such a system can then be used with a turbulent bath of liquid, or with pressurized fluid streams as disclosed in Example III.

EXAMPLE V

Still another method of processing fibrous glass fabric with a definite pattern of the pseudo-embossed effect comprises a two-step process. First, the fabric is printed with a pattern of a water resistant film forming substance which essentially immobilizes the fabric in the printed areas. Note that the pattern of printed areas is the negative of the desired pseudo-embossed pattern areas. Then, this printed fabric is treated by the repeated application of forces randomly throughout the fabric as achieved by any of the methods disclosed in the previous examples. Depending upon the medium and other conditions used for the pseudo-embossing process, a film forming substance which is more than just water resistant may be used. In any case, the film can afterward be removed during the heat setting process, and the fabric may then be finished, dyed, or printed in the conventional manner.

Note that the effects achieved by the methods of Examples III, IV, and V will not correspond precisely to the pattern of the fluid jets stencil-like die, or printed pattern. This is due to the stresses in the yarns in the weave patterns, particularly the tension which remains in the unprocessed sections of the fabric. Because of those forces a complete pseudo-embossing in those localized areas is not possible, although it is feasible enough to give a definite effect.

EXAMPLE VI

Examples I, III, IV, and V describe methods for imparting the present fabric effect which are essentially isolated or batch processes. However, each of these methods can be modified so that the process is adapted to the continuous processing of the fibrous glass fabric. In such a system the fabric is advanced into a treating zone wherein the section of fabric undergoing treatment is suspended in a fluid, and forces are randomly applied throughout the fabric while it is suspended to allow shifting of those portions of the fabric yarns being treated. Said yarns are thereby stress-relieved, and the fabric is advanced from the treating zone having the desired pseudo-embossed fabric effect. With this continuous process, the fabric can be continuously advanced through a heat treatment zone, emerging from that treatment with the pseudo-embossed effect permanently set into the fabric.

This continuous system consists of a set of rollers which meters the speed of the incoming fabric, followed by a length of slack fabric. This slack area is followed by the actual treating zone in which the fabric is loosely suspended in a fluid which applies the appropriate forces to the fabric to bring about the pseudo-embossed fabric effect. The actual treating zone can consist of any one or combination of the systems already shown in previous examples. This may be a large bath of liquid which is violently agitated by a series of reciprocating paddles. In any liquid bath system, the fabric must be essentially horizontal, or slowly cascading downward, to relieve internal stress insofar as possible. An alternate system is a series of fluid jets which impart a definite pattern into the fabric. Note that liquid jets may also be employed to increase agitation in the liquid bath system. Or, alternatively, a stencil-like die can be used with either fluid streams or a liquid bath. Likewise, the fibrous glass fabric printed with a pattern of a water resistant film forming substance may be continuously processed in the slack washer system or with fluid jets. In any of these treating systems, the extent of the fabric effect may be controlled by metering the treatment time by close control of the speed with which the fabric passes through the treating zone and the number of applications of force. The length of the treating zone can be designed so that an appropriate amount of fabric undergoes treatment for the desired length of time. After emerging from the treatment zone, another leader section of slack fabric is maintained before the fabric proceeds to heat treatment or other processing.

Regardless of the specific method used, the extent or degree of the fabric effect which may be achieved is limited for a particular fabric structure or original weave pattern. The effect is achieved progressively during the time of treatment, but the fabric eventually reaches a stage at which additional treatment evokes no further change in the fabric. For example, a plain taffeta weave fabric achieves a degree of effect after a twenty minute wash cycle in a household washing machine which is not increased or changed by additional treatment. However, if one removes samples of the fabric from the process at two minute intervals during the treatment, the progressive achievement of the fabric effect may be observed. This illustrates that the relief of stresses and compacting of the yarns into a final equilibrium configuration is a progressive process which is achieved only after the yarn stresses have been substantially relieved by this mechanical process. The progresive achievement of the fabric effect is not necessarily uniform, but the final equilibrium configuration gives an essentially uniform effect.

Although the present invention has been discussed as used on fibrous glass fabrics woven from yarns made of glass fiber coated only with the usual sizing compounds, it may be performed on fabrics woven with yarns coated with any substance which does not destroy the inherent stiffness and resiliency of the fibrous glass yarns, and which provides a coating which is slick enough to allow the yarn to shift easily within the limits of the weave pattern. For example, fibrous glass yarns coated with polyethylene, polypropylene, or polyvinyl chloride could be used in fabrics suitable for treatment in accordance with the present invention. Combination yarns of fibrous

glass strand plied with organic strand may also be used. Such combinations of viscous and glass yarns have been used. The same combination of glass and organic strands may be used in core yarns with the glass strand as either the core or the wrapper, and fabrics made with such yarns are suitable for treatment in accordance with the present invention. Indeed fabrics woven from yarns containing no glass whatsoever could lend themselves to the present invention if the properties of the yarns were such that stresses are produced in the yarns by the weave pattern, and the yarns are slick enough and the stresses large enough to allow the yarns to shift within the weave pattern to relieve the stresses in the yarns when treated in accordance with the present invention. Also, fabrics woven with blends of different types of combination and coated yarns can be processed by the method of the present invention.

Various modifications of the above described invention will be apparent to those skilled in the art, and such modifications can be made without departing from the spirit and scope of the present invention.

We claim:

1. An embossed fibrous glass fabric comprising warp and weft yarns, said yarns having been originally in a stressed condition due to their displacement from an essentially straight configuration into sinusoidal paths in the original fabric weave pattern, said yarns now lying in laterally and vertically shifted, stress-relieved, and compacted equilibrium configurations of the weave pattern providing a uniform pseudo-embossed fabric effect.

2. The fibrous glass fabric of claim **1** having the maximum possible pseudo-embossed effect wherein the warp and weft yarns lie in the final, essentially stress-relieved equilibrium configuration.

3. The fibrous glass fabric of claim **1** having a lightly pseudo-embossed effect wherein the warp and weft yarns lie in an intermediate, partially stress-relieved equilibrium configuration.

4. The fibrous glass fabric of claim **1** wherein the uniform pseudo-embossed fabric effect is permanently heat set into the fabric.

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WILLIAM A. POWELL, Primary Examiner

U.S. Cl. X.R.

161—93, 97, 128