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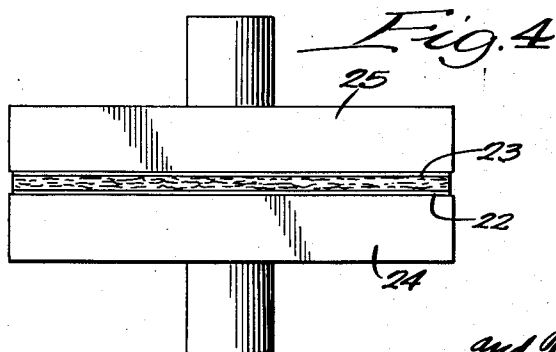
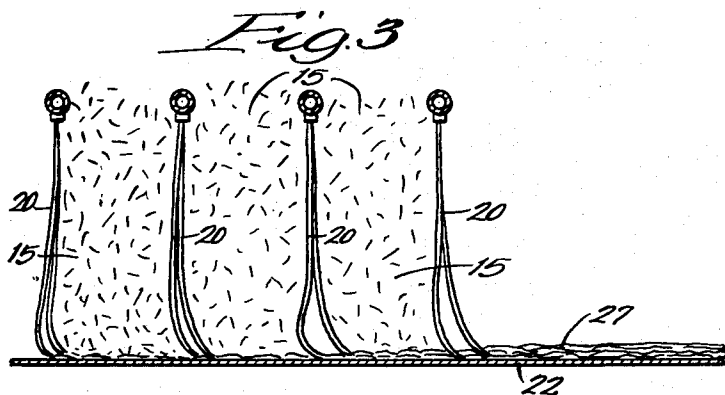
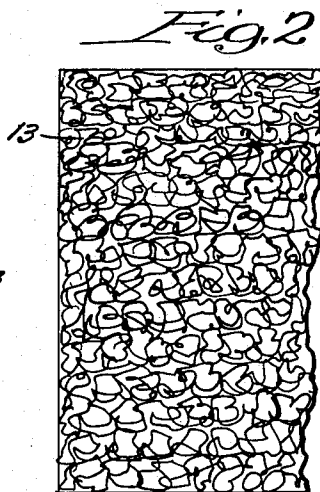
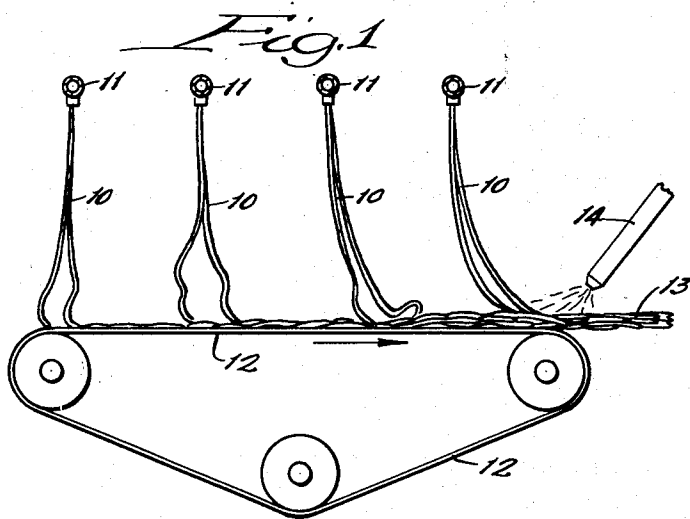
A. R. MORRISON ET AL

2,662,044

COATED FABRICS

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2 Sheets-Sheet 1



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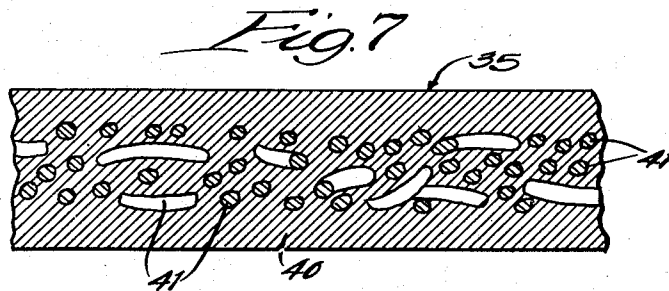
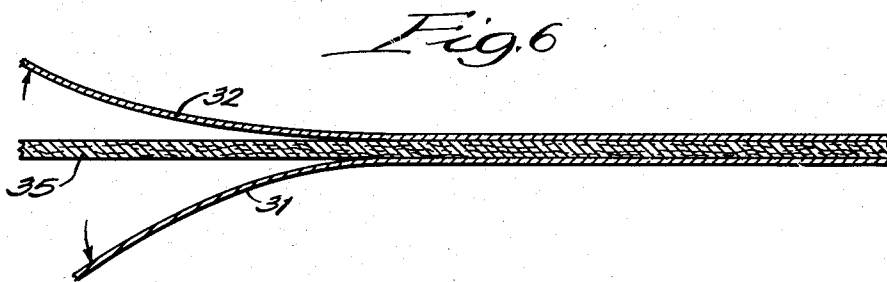
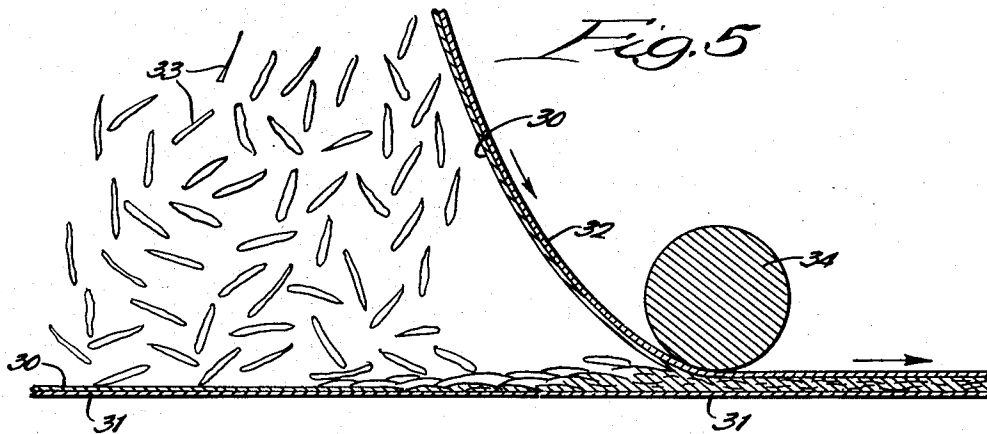
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,662,044

COATED FABRICS

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5 Claims. (Cl. 154—52)

1 This invention relates to coated fabrics and to the production and the method for manufacturing these fabrics. More particularly, it relates to a coated fabric wherein a mass of glass fibers in fabric form is treated in one or more combinations of steps, including impregnating and bonding, to provide a product having the integrated properties of glass fibers and resinous, resin-like, or rubber-like materials, preferably of a flexible, resilient nature.

Coated fabrics reinforced with glass fibers are not new. Such combinations of materials have been used quite extensively as leather substitutes in the manufacture of seat covers, book bindings, wearing apparel, purses, and the like. The accepted practice makes use of a woven fabric of glass fibers as the textile base to which the resinous coating composition is applied. Woven fabrics were used because it was believed that only in a woven fabric was there sufficient mass integrity to withstand the forces incident to normal handling and treating in the coating process; that only in a woven fabric could sufficient density be developed to permit proper coating in a few simple resinous applications; and that only in a woven fabric are the fibers in such predetermined arrangement as will lend desirable properties to the finished fabrics.

The high cost of weaving glass fibers adds materially to the cost of the base fabric, making it more difficult to compete with fabrics of cotton, wool, and other natural fibers in the manufacture of coated fabrics. Another objection to the use of woven fabrics of glass fibers as a reinforcement or base resides in the inability of woven fibers to move relative to one another to the extent that very little stretch is available. As a result, the fabric cannot be smoothly drawn about corners or bends as is often desired in the manufacture of fitted covers for furniture or the like. The coated fabric of woven glass fibers is considered to have poor flexure endurance, especially when compared to the product of this invention, being able to withstand only about five to ten thousand strokes of a standard flexure endurance test; whereas, the product of this invention has been able to withstand one-half million strokes, as hereinafter will be pointed out.

Favoring the use of glass fibers are their unusual strength, inertness, non-inflammability, dimensional stability, resiliency, fire resistance, rot resistance, moisture resistance, heat, chemical, and electrical resistance. It is desirable to make use of glass fibers as a base and as a reinforcement in coated fabrics, and it is most desirable to make use of glass fibers in the most economical

2 manner to the extent that glass fibers may assume their rightful position in the coated fabric field. In order to compete with natural fibers from a cost standpoint, it is desirable to use, as the base fabric, glass fibers which have not been expensively combined in fabric form. It has been found that economical use may be made of glass fibers as a base fabric in the form of mats of haphazardly arranged glass fibers. Glass fibers arranged in this form are considerably less expensive than woven structures, but their use is rendered more difficult by the fact that such mats generally have insufficient mass integrity to withstand the forces incident to normal handling operations and they are of such porous nature that a considerably greater amount of resinous material is required to coat the fabric to achieve the desired degree of imperviousness. In the same sense, more complicated procedures are required to deposit the resinous material and the like in the desired arrangement and concentration without casing undesirable redistribution of the fibers in the fabric reinforcement.

It is an object of this invention to provide a coated fabric reinforced with glass fibers and a method for producing the same, the product of this invention being able to compete costwise with coated fabrics otherwise reinforced, and which is, from the standpoint of certain physical characteristics, a vast improvement over the coated fabrics otherwise reinforced.

Another object of this invention is to produce a new and improved coated fabric reinforced with glass fibers which is low cost and more flexible and stretchable than coated fabrics reinforced with woven glass fibers.

A further object is to produce a fabric of the type described wherein glass fibers in unwoven form comprise the matrix and reinforcement for resinous or resin-like materials that comprise the continuous phase of the fabric which is suitable for many textile applications and as a leather substitute.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration but not of limitation various embodiments thereof are shown in the accompanying drawings in which:

Figure 1 illustrates a system for forming an endless web of continuous glass fiber filaments suitable for resinous treatment in fabric formation;

Figure 2 is a top plan view showing the arrangement of fibers in the fabric formed by the system of Figure 1;

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Figure 3 illustrates another system for forming a suitable fabric of glass fibers;

Figure 4 illustrates a method by which a coated fabric reinforced with glass fibers may be formed;

Figure 5 illustrates still another modification for forming a coated fabric reinforced with glass fibers;

Figure 6 shows the removal of supporting films used in the manufacture of a fabric embodying features of this invention according to the technique shown in Figure 5; and

Figure 7 is a sectional view through a coated fabric embodying features of this invention.

In carrying out our invention, the glass fibers which form the matrix are haphazardly arranged and when the coating materials are to be applied to the matrix, it is desirable that the glass fibers be held in the desired arrangement with a binder of the type which is either compatible or strongly adherent with a coating composition. When, on the other hand, the fibers are incorporated with or deposited on the coating material, interbonding is unnecessary as the coating substances are capable in themselves of serving as the bonding agent to anchor the fibers in the desired distribution or else combination is effected soon after fiber deposition in a manner which will not disturb the desired fiber arrangement.

It has been found that a greater degree of reinforcement by unwoven fibers is derived by the use of glass fibers in the form of bundles or ropes, and, therefore, such arrangements are specifically included in this invention. It has been further found that when in the form of bundles, the interstices between the fibers are of such scope and frequency that it requires a high proportion of resinous material to fill the interstices in a manner desired in an acceptable fabric. By the use of separated glass fiber filaments, such as cut, chopped, or milled glass fibers, in combination with the glass fiber bundles more substantially to close the interstices, considerable saving is made in the amount of resinous material required and the technique of coating is greatly simplified.

In one method, illustrated in Figures 1 and 2, a plurality of strands 10, each of which is formed with over fifteen continuous glass filaments, are run out of a plurality of guide eyes 11 arranged in spaced relation over a moving collecting belt 12. The strands 10 are run out at a linear speed much greater than that of the belt 12, and as the strands approach the belt, they naturally turn in circular paths to deposit as swirls 13. The swirls formed from strands by one guide eye may overlap or be overlapped by swirls formed from strands fed from the same or adjacent guide eyes. In their deposited relation, the glass fibers are more or less haphazardly arranged in a sheet-like layer with the filaments in substantial parallelism with the faces of the sheet. Many of the strands fed from a single guide eye remain together to form ropes.

Mass integrity of the deposited fibers in fabric form is secured by a binder to form a mat which will hereinafter be referred to as "swirl mat." The binder is of the type which is strongly adherent to the glass fiber surfaces and should be compatible or highly attracted to the materials which are to comprise the continuous phase or coating. Illustrative as suitable binder compositions are the acrylonitrile-butadiene copolymers (Buna N) which may be applied in solvent

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solution or in aqueous dispersion as a latex and in which the solid contents may range from 10 to 40 percent. Application may be simply effected by spraying the binder composition from a gun 14 as the fibers 10 are collected on the moving belt 12. If sufficient time and space are available, the diluent may be removed by a simple air dry but, more often, it is expedient to drive off the diluent by exposing the mat for 15 to 30 minutes to an atmosphere heated to 200° F. to 350° F. Sufficient mass integrity ordinarily is secured with the deposition of about 8 percent binder solids since the deposited resin ordinarily migrates to the junctures of the fibers where it is able more adequately to serve as the binding agent. The amount of deposited binder may, however, vary within rather broad limits since sufficient mass integrity may be secured with as little as 2 percent binder, and as much as 15 percent binder has often been used.

To form the coated fabric, the coating or impregnating resins, hereinafter referred to as the continuous phase, even though it does not necessarily completely impregnate the fabric, may be applied by a roller coating process. When so applied, it is best to use any conventional organosol, which consists of extremely finely divided particles of resin, such as a vinyl acetate-vinyl chloride copolymer, suspended in a non-solvent media. The media or diluent may be removed by exposure of the coated fabric to a temperature in the range of 200° F. to 350° F. for several minutes, and, after it is removed, the sheet may be calendered between heated rolls to impart desired characteristics.

The representative product secured by the described illustration based on a 10-15 mil mat has a thickness of about 21 mils and weighs about 24 ounces per square yard. It has a breaking strength of about 100 pounds per square inch and a flexure endurance of over one-half million strokes. This is to be compared to the flexure endurance of five to ten thousand strokes secured with substantially same combinations of materials reinforced with a woven glass fiber fabric of corresponding dimension. The increased flexure endurance is directly attributed to the greater freedom of relative movement between fibers and bundles of fibers which allows more stretch in all directions. As a practical matter, the increased stretchability enables broader use of the fabric in such applications as furniture covers and the like where it is desirable to draw a fabric over curves and corners to fit the cover to the curvature of the furniture without unsightly creases. The greater freedom of movement between fibers permits such fiber readjustments as will bring more fibers into alignment mutually to resist breaking forces.

Instead of acrylonitrile-butadiene binder, other suitable binder compositions may be used, bearing in mind that the binding agent is used to impart mass integrity to the mat without interfering materially with the freedom of movement by the fibers. Representative of other suitable binders are the polymeric resinous materials, such as polyvinyl chloride, vinyl chloride-vinyl acetate copolymer, polyvinyl acetate, vinyl acetate-vinyl chloride acrylonitrile copolymer, polyvinyl butyral, polyacrylates, polyalkylacrylates, polybutylene, and polyesters; and elastomers, such as butadiene-acrylonitrile which may be admixed with one half to twice its weight with a compatible A or B stage phenolic resin, isoprene-isobutylene

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copolymer, butadiene-styrene copolymer, chloroprene and natural rubber.

These may be applied in aqueous dispersions or as latex, but more often they are applied as organic solvent solutions or dispersions, suitable components of which may be selected from numerous solvent charts. The solids content depends more or less on the amount of binding agent which it is desired to deposit and the method of deposition. For spraying, the solids content is usually maintained in the range of 5 to 30 percent; for flow coating, the solids content may be higher, such as in the range of 5 to 50 percent. It is desirable usually to hold the binder content in the bonded fabric to 2 to 15 percent by weight, with 5 to 10 percent concentrations being best for most purposes. As previously pointed out, the diluent may be removed by an air dry or baking at elevated temperatures with or without the aid of vacuum conditions. The time and temperature to effect the desired removal and insolubilization of the bonding agent depends on the amount and type of diluent, but, usually, fifteen minutes at 250° F. to 300° F. are sufficient for water and solvents of like vapor characteristics, with lower temperatures or less time being required for lower boiling point solvents and vice versa for high boiling point solvents.

As the coating composition for a mat bonded with a suitable binder, selection may be made of the flexible or plasticized members of high polymeric film forming materials including the polyacrylates and polyalkylacrylates, such as methylmethacrylate, ethylacrylates, and butylmethacrylates; cellulose esters, such as cellulose acetate, cellulose propionate, cellulose nitrate, and the like; cellulose ethers including ethyl cellulose, benzyl cellulose; polyethylene, isobutylene, polyamides, flexible or elastomeric organo silicones (polysilicones), polyvinyl chloride (Geon), vinyl chloride-vinyl acetate copolymer (Vinylite), polyvinylidene chloride (Saran), vinylacetals, such as polyvinyl butyral; and elastomers, such as butadiene-acrylonitrile copolymer, butadiene-styrene copolymer, polychloroprene, isoprene-isobutylene copolymer, polysulphides, natural rubber, chlorinated rubber, and rubber hydrochloride.

Coating or impregnation may be made by the roller coating method previously described or by any other suitable method for depositing a relatively heavy film of material onto the surfaces of the fabric or for impregnating the fabric. For example, application may also be made by a knife coating process, a calendering process, or a dipping process. In either of these methods rather high viscosity coating compositions may be used, such as the organosols described. Application may be made from solvent solutions in which the maximum amount of coating material is incorporated. Plastisols which are free of diluent and in which fluidity is derived from the use of a plasticizer are advantageously used in coating processes. If plastisols are used drying to remove solvent and diluent prior to fusing at elevated temperature is not required. More often, however, a small amount of diluent is present and its removal may be effected by the use of elevated temperatures usually in the range of about 50° F. to 100° F. above the boiling point of the diluent. In actual practice, it appears that the coating composition has little tendency to soften or dissolve the binder holding the fibers together in the fabric.

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The concept of this invention includes the use of mats other than "swirl mat" wherein glass fibers in haphazard arrangement and even in completely separated form are bonded one to another by the use of a suitable adhesive present in amounts to impart self-sufficiency to the mat but enabling relative movement between the fibers under stress.

In the event that it is difficult to deposit sufficient coating composition in a single application, more than one treatment may be required. In this connection, we have found that an improved coated fabric may be produced; that is, less coating material is required, making it possible to achieve more substantial coverage in a single operation with less coating material when separated fibers of reinforced length are deposited with the swirled strands more substantially to close and fill the interstices of the mat or web. The separated fibers may be deposited in connection with the fabric forming process, as illustrated by the fibers 15 in Figure 3. They may be incorporated in the composition with which the mat is coated or various combinations of the described systems may be used. For example, when milled fibers are deposited with the strands in the production of "swirl mat," the suction ordinarily employed for holding the swirls onto the collecting belt apparently draws the milled fibers between the deposited coils substantially to fill the interstices and the resulting mat is easily coated in a single knife coating operation.

By the term "fibers of reinforced length," there are included fibers of ½ to 5 inches in length. Best results are secured when the interstitial filling fibers are ½ to 1 inch in length. Suitable fibers of the desired construction are secured by milling, cutting, or chopping filaments, threads, or yarns under controlled conditions.

By the method shown in Figures 3 and 4, glass fibers 20 are laid down in the manner of forming a "swirl mat" 21, with or without the conjoint deposition of milled or cut fibers 15 onto a continuous resinous film 22. When a sufficient concentration of fibers 20 has been deposited, another film 23 is draped over the deposited fibers and the assembled mass may be subjected to heat and pressure sufficient to integrate the two films 22 and 23 with the fibers sandwiched between to form a composite mass having the characteristics of a coated fabric. In the integrating step, pressures in the range of 50 to 300 pounds per square inch uniformly applied through platens 24 and 25 provided with heating and cooling means for 10 to 30 minutes with a temperature of 300° F. are sufficient when the film is polythene. It will be understood that the conditions of time, temperature, and pressure necessary to integrate the films and fibers in the desired manner will vary according to the characteristics of the highly polymeric substance, its film thickness, and the thickness or concentration of the glass fiber interlayer. The correct conditions for specific combinations of materials may be easily determined by the simple expedient of making a few trial runs.

It is conceivable that a corresponding product may be secured in a similar manner with the use of only a single film upon which the fibers are originally deposited. The films used in this process may be made of any of the described coating compositions which meet the require-

ments of flow under heat, heat and pressure, or just pressure alone.

Instead of depositing the glass fibers onto a dry film of high polymeric material, a very desirable fabric may be economically produced by depositing glass fibers, that is, continuous filaments, short lengths, and combinations thereof, onto a wet film for subsequent integration with or without a covering film. Conversion of the wet film to the desired impervious layer of the substantially continuous phase may be effected by the normal process for setting or hardening the high polymeric component, as by solvent evaporation, advancement of the polymeric material to a higher degree of polymeric growth, or by the use of heat and pressure, as in laminating or calendering processes. As a specific illustration, reference is made to Figure 5 wherein a vinyl chloride-vinyl acetate copolymer in high concentration (plastisol) is first deposited as a thin layer 30 between cellophane films 31 and 32. When parted, one face of each cellophane strip is coated with a thin layer of the wet plastisol. Thereafter, separated glass fibers 33 ranging from $\frac{1}{2}$ to 2 inches in length or else continuous strands, or both are rained down from above to deposit in haphazard but in fairly uniform distribution on the resinous layer 30 of the cellophane strip 31. After the desired amount of fibers have been deposited, the other strip 32 is brought over the top to sandwich the glass fibers therebetween in the manner of a laminate. The laminate is then cured for three minutes at 310° F. under a 30 pounds per square inch pressure. After separation of the cellophane films upon cooling, an integrated coated fabric 35 reinforced with glass fibers is secured having a tensile strength of about 21 pounds per square inch, breaking strength of about 87 pounds per square inch, and the fabric has excellent stretch characteristics.

The described wet process may be carried out with any of the high polymeric coating materials described which is readily separable upon hardening from the selected backing material corresponding to the cellophane strips 31 and 32. Instead of forming a layer of separated fibers on the wet coating composition, mats of continuous strands or yarns arranged in parallel or in haphazard or swirled or looped patterns may be used. The mats may be used alone or in combination with loosely assembled or separated fibers. These latter processes may be carried out on a batch principle or they may be arranged as a unit operation to form endless fabrics reinforced with glass fibers since either the film or the coated cellophane strips may be fed in endless lengths into a chamber depositing area and then led directly to the integrating or laminating element which may be of the compression roller type, illustrated by numeral 34.

For many applications, the wet process is to be preferred over the dry process because the wet layer of polymeric material is able to anchor the deposited fibers and prevent non-uniform rearrangements prior to the integration step. The wet substances are capable of greater flow under less rigid conditions of time, temperature, and pressure, and, as a result, more complete integration can be effected under conditions less harmful to the glass fibers and at less expense.

By a still further modification, the glass fibers of reinforcing lengths or others of the milled variety may be homogeneously mixed with the high polymeric material that is to comprise the

continuous phase. The composition is then sheeted, as by cooperating rollers and the like. In most instances, sheeting will involve heating and cooling steps if the plastic material in undiluted form is worked or it may involve setting by evaporation or reaction if a diluted composition or unrelated composition is sheeted by depositing a film on a table of the desired shape.

The ratio of fibers to high polymeric material in the final product depends on the characteristics of the polymer and the length and arrangement of the glass fibers. The glass fiber concentration may be greatest when shorter lengths are used and the strength of the resulting fabric may be increased by the use of longer fiber lengths and fiber bundles. It will be evident that combinations of the systems described may be used wherein a mat of glass fibers is impregnated or coated with a high polymeric substance in which separated glass fibers or milled glass fibers are incorporated.

It will be understood that the procedures described are given by way of illustration and not by way of limitation and that various combinations of the desired methods and materials may be secured without departing from the spirit of the invention, the product of which is a new and improved fabric of the type preferably having a stretchable resinous material 40 as the continuous phase reinforced with glass fibers 41 in haphazard arrangement and shiftable relative to each other. Because of the novel manner in which the fibers are incorporated, the fabric is less expensive and it is better able to compete with coated fabrics reinforced with woven glass fibers and other types of fabrics based upon natural fibers. Because of the permissible relative movement between fibers and the flexibility of the coating material, a high degree of stretch is secured which enhances the usefulness of the fabric in many old and in innumerable new applications. The tensile and tear strengths of the fabric are very high because large numbers of fibers are able to shift relative to each other in the fabric to distribute the strength among themselves in opposition to forces tending to break the fabric. Because of the arrangement whereby milled, cut or chopped fabrics are arranged as elements to close the interstices between fibers, considerable saving in material is secured and the technique for coating is greatly simplified. In addition to the above, the properties of glass fibers and resinous or elastomeric materials become integrated whereby the fabric is characterized by heat resistance, weather resistance, electrical resistance, wear resistance, dimensional stability, and relative inertness of glass fibers.

It will be understood that when stretchability and flexibility are not factors, compositions based on harder resin modifications and even resinous materials of the thermosetting type may be used as a coating composition and that numerous other changes in the sequence of operations and conditions may be made without departing from the spirit of the invention, especially as defined in the following claims.

We claim:

1. An article of manufacture comprising a thin web of glass fibers in which the fibers are present in the form of endless lengths arranged in swirl patterns in overlapping relation, a thermoplastic resinous material binding the fibers one to another into a thin, non-woven textile and providing a receptive base for anchorage of a thermoplastic coating material onto the glass fiber sur-

faces, and a thermoplastic high polymer forming a continuous coating on the surfaces of the thin non-woven textile to produce a coated fabric having high flexibility, the thermoplastic binder being selected from the group consisting of butadiene-acrylonitrile copolymer, polyvinyl chloride, vinyl chloride-vinyl acetate copolymer, polyvinyl acetate, vinyl acetate-vinyl chloride acrylonitrile copolymer, polyvinyl butyral, polyacrylates, polyalkylacrylates, polybutylene, polyesters, polysiloxanes, isoprene-isobutylene copolymer, butadiene-styrene copolymer, chloroprene, and a latex, and in which the high polymer for the surface coating is selected from the group consisting of vinyl polymers, vinyl derivative polymers and vinyl copolymers, polyethylene, polyamides, polyacrylates, polyalkylacrylates, butadiene-acrylonitrile copolymer, butadiene-styrene copolymer, chloroprene, isoprene-isobutylene copolymer, chlorinated rubber, rubber hydrochloride and a rubber latex.

2. An article of manufacture comprising a thin web of glass fibers in which the fibers are present in bundles of endless lengths arranged in swirl patterns in overlapping relation, a thermoplastic resinous material binding the fibers one to another into a thin, non-woven textile and providing a receptive base for anchorage of a thermoplastic coating material onto the glass fiber surfaces, and a thermoplastic high polymer forming a continuous coating on the surfaces of the thin non-woven textile to produce a coated fabric having high flexibility, the thermoplastic binder being selected from the group consisting of butadiene-acrylonitrile copolymer, polyvinyl chloride, vinyl chloride-vinyl acetate copolymer, polyvinyl acetate, vinyl acetate-vinyl chloride acrylonitrile copolymer, polyvinyl butyral, polyacrylates, polyalkylacrylates, polybutylene, polyesters, polysiloxanes, isoprene-isobutylene copolymer, butadiene-styrene copolymer, chloroprene, and a latex, and in which the high polymer for the surface coating is selected from the group consisting of vinyl polymers, vinyl derivative polymers and vinyl copolymers, polyethylene, polyamides, polyacrylates, polyalkylacrylates, butadiene-acrylonitrile copolymer, butadiene-styrene copolymer, chloroprene, isoprene-isobutylene copolymer, chlorinated rubber, rubber hydrochloride and a rubber latex.

3. An article of manufacture comprising a thin web of glass fibers in which continuous lengths of fibers are arranged in a swirl pattern in over-

lapping relation and other glass fibers cut to short lengths are disposed within the interstices between the swirls of continuous fibers, a thermoplastic resinous material binding the fibers one to another into a thin, non-woven textile and providing a receptive base for anchorage of a thermoplastic coating material onto the glass fiber surfaces, and a thermoplastic high polymer forming a continuous coating on the surfaces of the thin non-woven textile to produce a coated fabric having high flexibility, the thermoplastic binder being selected from the group consisting of butadiene-acrylonitrile copolymer, polyvinyl chloride, vinyl chloride-vinyl acetate copolymer, polyvinyl acetate, vinyl acetate-vinyl chloride acrylonitrile copolymer, polyvinyl butyral, polyacrylates, polyalkylacrylates, polybutylene, polyesters, polysiloxanes, isoprene-isobutylene copolymer, butadiene-styrene copolymer, chloroprene, and a latex, and in which the high polymer for the surface coating is selected from the group consisting of vinyl polymers, vinyl derivative polymers and vinyl copolymers, polyethylene, polyamides, polyacrylates, polyalkylacrylates, butadiene-acrylonitrile copolymer, butadiene-styrene copolymer, chloroprene, isoprene-isobutylene copolymer, chlorinated rubber, rubber hydrochloride and a rubber latex.

4. An article of manufacture as claimed in claim 1 in which glass fibers cut to short lengths are uniformly distributed in the high polymeric surface coating on the non-woven textile.

5. An article of manufacture as claimed in claim 1 in which a coloring component is incorporated into the high polymeric material surface coating the non-woven textile to impart color of the desired character to the flexible coated fabric.

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