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(54) Flame resistant yarns and fabrics.

(57) An inherently flame-retardant yarn comprises a multifilament glass fibre core covered with a staple fibre adhered to a polymer coating around the core. The yarn can be knitted on a weft knitting machine without damage to the glass fibre filaments, and the resulting knitted fabric is of particular use in providing a flame-retardant sublayer for upholstery and soft furnishings.

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TITLE:

Flame resistant yarns and fabrics

DESCRIPTION:

Technical Field

The invention relates to novel yarns having intrinsic flame-resistant properties, and to novel fabrics made from such yarns; and proposes a novel use of such fabrics in furnishings to impart a good flame resistance thereto.

Background Art

A variety of flame-resistant yarns is known, having inherent flame-resistant properties which vary from yarn to yarn. Some such yarns will burn if the temperature is sufficiently high, some owe their flame-resistance to surface treatment which can wear or wash away, and some are made from fibres which are themselves inherently incapable of supporting combustion. The most satisfactory flame-resistant yarns fall within the latter category. Glass-fibre

yarn, which has this desirable property of inherent incombustibility, is however basically unsuitable for making up into furnishing fabrics because on the one hand it is brittle and cannot satisfactorily be knitted on a weft knitting machine, and on the other hand it does not handle well and tends to shed short broken filaments or fibrils which are a skin irritant. The above two disadvantages have confined the use of glass fibre fabrics to a field well removed from upholstery and upholstery furnishing fabrics.

One proposal to modify a glass-fibre based yarn has been made in British Patent Specification No. 1,117,960. In that Specification a glass-fibre core is coated with a flocking layer of short radially oriented ends of fibrous material. The flocking layer is secured to the glass-fibre core by adhesive. The resulting composite yarn has quite unique properties as the radially extending flock prevents it from sliding over itself. Suggested uses are in motor tyres, packing materials and filter cloths. There is no suggestion of being able to knit or weave the yarn, which indeed would be impossible to process on conventional textile machinery.

One most acute need for a reliable and economical flame-resistant fabric is in upholstered furniture when the fabric is used to cover foamed polyurethane.

The polyurethane is very inflammable, and is all

the more dangerous because while burning it emits large quantities of highly toxic smoke. Many fires start with cigarette ends being dropped on the furniture, melting the outer fabric and igniting the foamed polyurethane. Thus it is not sufficient, as a fire retardant measure, even to cover the foamed polyurethane with a flame-resistant fabric. If that fabric is low-melting, then it will simply melt on the application of heat to expose the inflammable polyurethane foam below.

With glass fibre fabrics being unsuitable for upholstery and furnishings for the reasons stated above, furniture manufacturers have turned to other fibres for their furnishing fabrics, but have failed to find an ideal fabric which is inexpensive and which has all of the desirable wear properties of the vast range of fabrics currently available and used. Accordingly furniture is still made and sold which is a very real fire hazard, and legislation to prevent its sale is held back pending discovery of a satisfactory fibre and fabric for covering the foamed polyurethane to render it flameproof while retaining all of the appearance of the finished furniture which consumers have come to expect.

Disclosure of the Invention

This invention provides a novel yarn which has

intrinsic flame-resistant properties, which has a good 'hand' and 'feel', which is sufficiently flexible to be knitted on a weft knitting machine, and which is relatively inexpensive to manufacture.

The novel yarn of the invention is a covered yarn comprising a multifilament glass fibre core covered with a staple fibre which extends helically around the core and is adhered to a polymer coating around the core. Preferably the staple fibre is embedded along the whole or substantially the whole of its length in the polymer coating.

The technology is available for making a coated yarn according to the invention, using a Bobtex ICS (integrated composite spun) machine ("Bobtex" is a Trade Mark). The glass fibre core yarn is passed continuously through a solution of the polymer or through the molten polymer, to provide the core with its adhesive surface coating. Subsequent passage of the coated core yarn between opening rollers which rotate to open a sliver of staple yarn enables fibrils of the staple fibre to be adhered to the coating, and the yarn is then advantageously passed through a false twisting device, so as more firmly to anchor the staple fibres to the polymer of the composite yarn.

Although the above integrated composite spinning technology is not new, it is a novel proposal to apply this technology to a glass fibre core yarn. The result is, most surprisingly, a composite yarn that handles well and which can be bent or kinked to an extent never before considered possible with glass fibre yarns. Indeed the yarn can be easily knitted into fabrics on a weft knitting machine such as a high speed circular knitting machine, which was not previously possible with any glass fibre-based yarn.

Also, tests have shown that the tensile strength of the glass fibre core yarn is increased by at

least 10% during its formation into the integrated composite spun yarn of the invention.

Moreover the knitted fabric, and the yarn itself, can be handled without the usual irritant effect on the skin due to broken ends of glass fibres. This lack of irritation is probably due to the action of the polymer coating and the helically wrapped staple fibre in retaining any broken ends of glass fibres within the yarn.

Because the glass fibre core of the yarn of the invention is inherently flame-resistant and high melting, these same properties are passed to the covered yarn. Advantangeously however, the polymer coating and/or the staple fibre covering also have flame-resistant properties, to improve even further the flame-resistance of the covered yarn. Examples of suitable polymer coatings include polypropylene/ethylene-vinyl acetate mixtures, and PVDC or SARAN (Trade Mark) of which the latter two are flame-resistant. Examples of suitable staple fibres include natural fibres (particularly wool, which is naturally flame-resistant), polyester fibres, SEF acrylic (SEF is a Trade Mark), carbon fibre and NOMEX (Trade Mark) of which the latter three are flame-resistant or self-extinguishing.

The invention also provides a range of fabrics made from yarns according to the invention. The extent of the range, and the different feel and other properties presented by the various fabrics, illustrates very well the surprising versatility of the yarns of the invention. All such fabrics have the attribute of flame resistance, however.

One useful range of fabrics is made simply by plain knitting a yarn according to the invention. As stated above, this can be carried out on a high speed circular knitting machine to produce a low unit cost stockinette fabric. For the first time the advantages of stretch and flexibility of a stockinette fabric are combined with the advantages of strength and flame resistance of glass fibre. There are however other advantages. The 'feel' or 'hand' of the fabric can be varied by choosing different staple fibres for incorporation into the initial yarn, without destroying the inherent flame resistance of the fabric. The knitted fabric is also sufficiently inexpensive to use as a flame-resistant interling in upholstered furniture, for example to cover and provide a flame barrier around any combustible polyurethane foam that might be used.

Fabrics according to the invention may alternatively be made by weaving the composite yarns. Weaving of glass fibre yarns is of course known in itself, but woven fabrics of the invention are capable of after-treatment into an exciting range of different forms. For example, a tight-woven and heavy fabric of the invention can be rendered very much more flexible and compliant by immersion in an organic solvent for the polymer coating. The solvent removes some or all of the polymer of the coating to which the staple fibre adheres, but because the staple fibre is wrapped helically around the glass fibre core and because the fabric is tight-woven, the staple fibre remains an integral part of the fabric. Such a fabric has an improved 'hand' which is a characteristic of the staple fibre used, while retaining all of the strength and flame retardance associated with woven glass fibre fabrics. It is particularly suitable for firemen's uniforms and other safety clothing, and surprisingly even after removal of a major part of the polymer from the fabric, there is little tendency for the fabric to shed broken ends or fibrils of a glass fibre in use.

An alternative, and totally different, range of fabric materials can be obtained by weaving a yarn according to the invention into a fairly tight woven fabric and then hot calendering that fabric under conditions which cause the polymer coating around the core yarn to melt. The melted polymer coating is caused to flow, under the heat and pressure of the calendering process, until it forms or partially forms a film across the fabric. The result is a non--fray fabric material which is eminently suitable for use in roller blinds, vertical louvre blinds, flame-proof partitions, stage scenery and many other applications. The material has a paper-like quality, has immense strength, is flexible, is water proof and can be printed easily and reliably. Also, of course, it has the flame resistance which is a characteristic of all fabrics according to the invention.

Best Mode of Carrying Out The Invention

A fibre and fabric according to the invention were prepared as follows using a commercially available continuous glass filament yarn, namely Owens Corning EC968 (1/0) Z20 679 fibre glass (Trade Mark), which is a 68 tex, Z direction twist, 20 filament yarn.

The glass fibre yarn was tensioned and passed through a fine tube into an area of molten polymer at a speed of approximately 600 metres per minute. In the example quoted the polymer was a compound of 60% ethylene-vinyl acetate, being Imperial Chemical Industries' Evatane (Trade Mark) 28.20 (28% vinyl acetate content; 20 melt flow index) and 40% Polypropylene, Shell Chemicals' SY6100, at a temperature of 230°C.

Molten polymer was presented to the point of contact with the filament glass by means of an extruder at a constant rate of 16 grams per minute. As the glass filaments pass through the molten polymer the polymer forms a cone around the running glass and is drawn down to form a very fine coating around the glass filament. Whilst the polymer was still in a molten state staple fibres were presented to the molten polymer coating by means of a fibre opening system so that the individual fibres partially penetrated

or adhered to the polymer. The combination of glass/polymer/fibre was then passed through a false twist process which further acted to impress the individual fibres into the polymer coating to form a composite yarn. The yarn was allowed to cool and solidify prior to winding on a conventional textile package.

A subsequent rewinding process was used to lubricate the yarn with a paraffin or silthane wax in the conventional manner before winding onto a conventional textile cone suitable for presentation to a knitting machine.

The resultant yarn was then knitted without fracture on a conventional knitting machine, for example a conventional single jersey weft knitting 12 gauge machine at commercial speeds, to produce a single jersey fabric without filamentation of the glass.

In the example outlined the particular fabric described was manufactured as a reinforcing fabric for a vinyl coating for upholstery, so that should the vinyl be melted by, for example, a cigarette end the fibres and polymer will similarly melt but the glass knitted structure will remain intact to prevent the passage of the lighted cigarette end

into the upholstery foam beneath, thereby creating a physical barrier that will not be destroyed below the melting point of the glass. Further fabrics of glass composite yarn have been manufactured using different, and inherently flame proof, polymers and fibres that themselves will not ignite or support combustion.

Industrial exploitation

The invention also provides a fabric knitted from the above coated yarn on a weft knitting machine. The fabric may be plain knit, and may be on any gauge of machine suitable for the tex of the yarn produced. The resulting fabric has the appearance of stockinette fabric, with good flexibility and stretch characteristics. One particularly important feature is the good abrasion resistance, which is many times greater than that of conventional woven glass fibre fabrics and which opens up a wide range of uses for the fabrics of the invention.

The invention proposes a number of novel and useful applications for such a fabric. A first use is as a flame barrier layer in soft furnishings. A second is as a base fabric for vinyl and simulated leather upholstery materials. A third use is as a cladding to wrap around electrical installations

or as a heat insulation bandage for pipework. A fourth use is as a reinforcement for thermoset resin mouldings.

When using the fabric of the invention in soft upholstery furnishings as a flame barrier layer, the article to be upholstered such as a foamed polyurethane cushion is first encased in a fabric according to the invention. Preferably the polyurethane is stiched completely into a cover of the fabric of the invention. An outer cover of conventional upholstery material is then provided. The outer cover may be either a flame-resistant fabric or one that burns; the provision of a sublayer of the fabric of the invention provides a flame barrier that effectively isolates the foamed polyurethane which is the most dangerous part of the furniture from the point of view of fire hazard.

Tests have shown that burning cigarettes do not ignite upholstered furniture covered as described above. If the outer cover is a low-melting fabric then the cigarette end will melt a hole through to the sublayer of the fabric according to the invention, where it will char, melt or otherwise destroy the staple

fibre covering of the yarn forming the fabric of the invention. The glass fibre core of the covered yarn is not destroyed, however, and continues to present a flame-resistant barrier between the cigarette end and the polyurethane.

More extreme tests with naked flames have had equally favourable results.

Because of the inherent stretch properties of a knitted fabric according to the invention, it can be incorporated as a sublayer beneath the outer cover of upholstered furniture without any adverse effects, on the feel of the finished furniture. Moreover as a fire retardant measure it is very economical; much more so than the incorporation of fire retardant chemicals into the polyurethane foam. The final choice of surface fabric is not dictated by fire retardant considerations, which gives much more choice to the furniture designers.

Applications of this use of fabric according to the invention include cushion covers, upholstered chairs, settees, mattresses, beds, car seats and the seats of public service vehicles such as trains, omnibuses and aircraft.

When using the fabric of the invention as a base layer for vinyl or simulated leather sheeting, the plain

knit fabric of the invention is simply substituted for the stockinette base fabric conventionally used. The result is a vinyl sheet with inherent fire-resistant properties. Although the vinyl covering itself might melt or burn away in a fire, the knitted base fabric of the invention will not burn and will maintain its integrity up to the melting point of the glass.

When using the fabric of the invention as a reinforcement for sheets or mouldings, of theremoset resin, conventional moulding techniques should be followed. However the fabric is much easier to handle than conventional glass fibre matting because on the one hand it does not have the same skin irritant effect and on the other hand its inherent stretch characteristics, resulting from the knitted structure, enable it to be formed into more complex shapes without creasing.

CLAIMS:

1. A covered yarn comprising a multifilament glass fibre core covered with a staple fibre which extends helically around the core and is adhered to a polymer coating around the core.

2. A covered yarn according to claim 1, wherein the staple fibre is embedded along the whole or substantially the whole of its length in the polymer coating.

3. A covered yarn according to claim 2, wherein the staple fibre has been applied to the core by first coating the core with molten polymer and then passing the coated core through a zone in which opened ends of the staple fibre are transferred onto the polymer to adhere thereto.

4. A covered yarn according to claim 1, wherein the polymer coating has flame-retardant properties.

5. A covered yarn according to claim 4, wherein the staple fibre covering has flame-retardant properties.

6. A knitted fabric comprising a covered yarn according to claim 1 that has been plain knitted on a weft knitting machine.

7. A woven fabric comprising a covered yarn according to claim 1, wherein after weaving the polymer of the polymer coating has been wholly or partially removed with a solvent.

8. A woven fabric material comprising a covered yarn according to claim 1, wherein after weaving the fabric has been hot calendered to cause the polymer of the polymer coating at least partially to melt and form a film across the fabric.