(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
02 January 2020 (02.01.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/002873 A1

(51) International Patent Classification:
D02G 3/32 (2006.01) *D02G 3/44* (2006.01)

(21) International Application Number:
PCT/GB2019/051651

(22) International Filing Date:
14 June 2019 (14.06.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1810691.4 29 June 2018 (29.06.2018) GB

(71) Applicant: **ARVILLE TEXTILES LIMITED** [GB/GB]; Arville House, Sandbeck Way, Wetherby, Leeds Yorkshire LS22 7DQ (GB).

(72) Inventors: **BEADLE, Robert**; 22 Cyprus Drive, Thackley, Bradford Yorkshire BD10 0AJ (GB). **HULL, Nigel**; 27 Esk Garden, Wetherby, Leeds Yorkshire LS22 7UR (GB).

(74) Agent: **TANDEM PATENTS LIMITED**; Grange Farm, Wetherby Road, Little Ribston, Wetherby Yorkshire LS22 4EP (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: FIRE-RESISTANT CABLED YARN AND TEXTILE

(57) Abstract: The present application describes a cabled yarn (200) comprising at least two single plied yarns (100) each comprising meta-aramid fibres, para-aramid fibres, cellulose-based fibres, and wool fibres, twisted around a centrally located yarn (110) comprising a substantially elastic fibre. A fire-resistant textile material comprising the yarn, a garment comprising the material, and a method of manufacturing the yarn and material are also described.

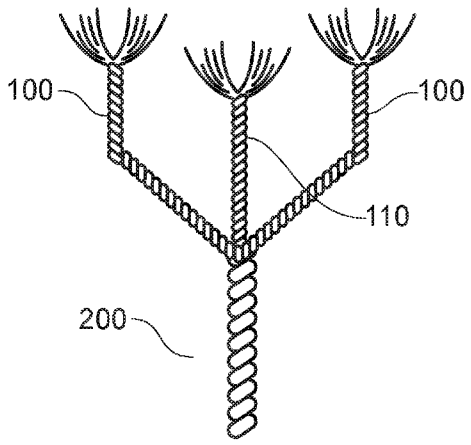

FIG. 1

WO 2020/002873 A1

FIRE-RESISTANT CABLED YARN AND TEXTILE

The present invention relates to fire resistant textile materials and to garments manufactured from such materials. In particular, but not exclusively, the present invention relates to articles of fire resistant clothing for use by fire fighters, military personnel and police officers, or the like, and to textiles for manufacturing such clothing.

Clothing for protection against heat and flame must pass minimum performance requirements for flame, radiant heat, heat resistance, tensile and tear strength, and penetration by water and liquid chemicals. The assembled garments, which typically include a pair of trousers/salopettes and a jacket, must protect the wearer from radiant and thermal exposure, and unexpected flashover conditions, whilst still maintaining an adequate level of dexterity and comfort.

As described in WO2015/008030, it is known to reduce second and third degree burns to a wearer by ensuring the barrier of protective clothing located between the heat source and the wearer's skin remains intact during exposure to heat and flame whilst ensuring an air gap exists between the skin and the heat source. It is also known to provide a single woven layer of fire resistant textile material which utilises the strength characteristics of meta-aramid fibres in a warp yarn and the moisture management properties of wool in a blended wool and cellulose weft yarn for direct contact against a wearer's skin.

However, conventional fire-resistant textile materials are relatively heavy, allow for limited movement, and do not sufficiently and efficiently move moisture in the form of sweat away from the skin which can otherwise result in steam/scald burns. Furthermore, the demand for fire-resistant garments which are lighter in terms of weight and with improved comfort, breathability and moisture management is ever increasing.

It is an aim of certain embodiments of the present invention to provide a fire-resistant textile material which is lightweight, breathable, strong, durable and comfortable.

According to a first aspect of the present invention there is provided a cabled yarn comprising:

at least two single plied yarns each comprising meta-aramid fibres, para-aramid fibres, cellulose-based fibres, and wool fibres, twisted around a centrally located yarn comprising a substantially elastic fibre.

Optionally, the cabled yarn comprises by weight at least 10% of said meta-aramid fibres.

Optionally, the centrally located yarn comprises ethylene and at least one olefin.

Optionally, the centrally located yarn comprises Elastolefin™.

Optionally, the cabled yarn comprises by weight around 23% meta-aramid fibres, around 4% para-aramid fibres, around 33% cellulose-based fibres, around 33% wool fibres, and around 7% Elastolefin™ fibres.

Optionally, the cellulose fibres comprise a fire-retardant viscose fibre.

Optionally, the wool fibres have a thickness of around 15.5µm to around 29.5µm.

Optionally, the meta-aramid fibres comprise Nomex™.

Optionally, the para-aramid fibres comprise Kevlar™.

According to a second aspect of the present invention there is provided a fire-resistant textile material comprising a yarn according to the first aspect of the present invention.

According to a third aspect of the present invention there is provided a garment comprising a material according to the second aspect of the present invention.

According to a fourth aspect of the present invention there is provided a method of manufacturing a cabled yarn, comprising:

twisting at least two single plied yarns each comprising meta-aramid fibres, para-aramid fibres, cellulose-based fibres, and wool fibres, around a centrally located yarn comprising a substantially elastic fibre.

Optionally, each single plied yarn comprises by weight at least 10% of said meta-aramid fibres.

Optionally, the centrally located yarn comprises ethylene and at least one olefin.

According to a fifth aspect of the present invention there is provided a method of manufacturing a fire-resistant textile material, comprising:

weaving yarn according to the first aspect of the present invention in both warp and weft directions.

Optionally, the weave is a twill weave.

Description of the Drawings

Certain embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates a 'cabled' three-ply yarn according to certain embodiments of the present invention.

Detailed Description

According to certain embodiments of the present invention, a single ply yarn includes a blend of paraphenylene isophthalamide (meta-aramid) fibres, cellulose-based fibres, wool fibres, and polyparaphenylene terephthalamide (para-aramid) fibres. Aptly, the meta-aramid fibre is Nomex™ and the para-aramid fibre is Kevlar™. Aptly, the cellulose-based fibre is Lenzing™ FR.

As illustrated in Figure 1, two of these single ply yarns 100 are twisted together with a third yarn of substantially elastic fibre 110 to form a 'cabled' three-ply yarn 200. The elastic fibre 110 is located centrally with the single ply yarns 100 twisted therearound to provide effective cover and protection to the elastic fibre. Aptly, the centrally located elastic fibre yarn 110 comprises Elastolefin™ which is a fibre composed of at least 95% (by weight) of macromolecules partially cross-linked, made of ethylene and at least one other olefin. When stretched by up to 50% of its original length, it recovers rapidly to its original length.

Aptly, the composition (by weight) of the fibre components of the cabled yarn 200 is:

- around 33% Lenzing™ FR;
- around 33% wool;
- around 23% meta-aramid (Nomex™);
- around 7% Elastolefin™ XLA; and
- around 4% para-aramid (Kevlar™).

Aptly, the yarn comprises at least 10% meta-aramid, and may be more subject to the wool/Lenzing™ content by weight being reduced accordingly.

Aptly, the yarn 200 may include around 2% antistatic fibres (e.g. carbon fibres).

Aptly, the Lenzing™ FR fibre has a linear mass density of around 2.2 dtex and comprises a fire-retardant viscose fibre. The Lenzing™ fibres offer moisture management with its efficient moisture wicking and transportation properties when worn next to the skin of a wearer in combination with its quick drying and comfort properties.

The wool fibres have a thickness of between around 15.5-29.5 μm, and aptly around 19.5 μm which has been found to be optimum in terms of efficient and effective transportation of moisture from the skin and across adjacent fibres. The wool fibres are treated to be shrink resistant. The wool fibres are hygroscopic such that they can hold up to a third of their own weight in moisture without feeling wet thereby helping to wick away sweat whilst enhancing comfort. The hygroscopic properties of the wool fibres also help to regulate temperature and humidity, creating a buffer area

(i.e. holds moisture without feeling wet), enhancing comfort. Furthermore, the chemical building blocks of wool, i.e. amino acids, are hydrophilic (water-liking) such that they attract and absorb water molecules into the chemical structure of the fibre. Water binds within the wool structure through the action of hydrogen bonds in a process known as absorption. Wool is inherently antimicrobial and antistatic which enhances comfort and protection. Wool has a helical configuration in the centre of the fibre which acts like a shock absorbing spring under compression which further enhances comfort for a wearer.

Nomex™ yarn is typically available in three types based on the linear mass density (2.2 dtex, 1.7dtex and 1.4dtex). Aptly, a 1.4dtex Nomex™ yarn is used as it offers desirable comfort and flexibility in view of its fineness.

The XLA fibres have a linear mass density of around 117 dtex. XLA is particularly fire-resistant, robust and accommodates high levels of activity and movement to provide enhanced comfort for many different applications.

Kevlar™ is a preferred para-aramid fibre in view of its high strength, chemical resistance, excellent durability and thermal stability. The para-aramid fibre is around 1.7 dtex / 50 mm staple length as it is aptly a spun yarn.

The cabled three-ply yarn 200 is aptly used to provide a textile according to certain embodiments of the present invention which may be used for a fire-resistant garment, e.g. a fire fighter's jacket. The weave is aptly a 2x2 twill weave but other suitable weave patterns may be used such as a plain weave, 2x1, 3x1, 4x1 or 2x2 twill weaves, ripstop or hopsack weaves, satin, or sateen weaves, or the like. A 2x2 twill weave is desirable because it allows movement when shrinking down the fabric for stretch due to float size. A twill weave also desirably provides a tighter, denser construction which enhances the dimensional stability and increases durability after multiple washing. The cabled three-ply yarn 200 is in both warp and weft directions to desirably provide stretch in all four directions (horizontally, vertically, and diagonally) thereby providing optimal comfort to a wearer of a garment made from the textile.

The textile is scoured, heat sett and pressed to provide a smooth and comfortable garment. Such a garment may include trousers, salopettes, jackets, overalls, T-shirts, facemasks, falsehoods, or the like. Applications for such a garment may include tackling wild land fires, electric arc protection, petrochemical applications, search & rescue, forestry, police violent situation/riot protection, military, or the like.

In accordance with certain embodiments of the present invention, the final yarn may comprise more than three plies, e.g. four or more plied yarns twisted around a centrally located and substantially elastic yarn. For example, the final yarn may include antistatic fibres. A multi-ply yarn is often known as a cabled or hammer yarn.

A key technical advantage of utilising these yarns in personal protective equipment (PPE) applications, particularly fire-resistant garments, is to provide a stretch material to maximise comfort whilst maintaining strength and integrity and offering sufficient protection against flame and heat. The aramid fibres offer strength and robustness to withstand wear during use and to hold the material together during flaming/extreme heat exposure, whilst the XLA fibres provide desirable stretch. The 'maypole' construction of the cabled yarn desirably protects the centrally located XLA yarn against flame, heat, UV, or the like.

Claims

1. A cabled yarn comprising:

at least two single plied yarns each comprising meta-aramid fibres, para-aramid fibres, cellulose-based fibres, and wool fibres, twisted around a centrally located yarn comprising a substantially elastic fibre.

2. The yarn according to claim 1, comprising by weight at least 10% of said meta-aramid fibres.

3. The yarn according to any preceding claim, wherein the centrally located yarn comprises ethylene and at least one olefin.

4. The yarn according to claim 3, wherein the centrally located yarn comprises Elastolefin™.

5. The yarn according to claim 4, comprising by weight around 23% meta-aramid fibres, around 4% para-aramid fibres, around 33% cellulose-based fibres, around 33% wool fibres, and around 7% Elastolefin™ fibres.

6. The yarn according to any preceding claim, wherein the cellulose fibres comprise a fire-retardant viscose fibre.

7. The yarn according to any preceding claim, wherein the wool fibres have a thickness of around 15.5µm to around 29.5µm.

8. The yarn according to any preceding claim, wherein the meta-aramid fibres comprise Nomex™.

9. The yarn according to any preceding claim, wherein the para-aramid fibres comprise Kevlar™.

10. A fire-resistant textile material comprising a yarn according to any preceding claim.

11. A garment comprising a material according to claim 10.

12. A method of manufacturing a cabled yarn, comprising:

twisting at least two single plied yarns each comprising meta-aramid fibres, para-aramid fibres, cellulose-based fibres, and wool fibres, around a centrally located yarn comprising a substantially elastic fibre.

13. The method according to claim 12, wherein each single plied yarn comprises by weight at least 10% of said meta-aramid fibres.

14. The method according to claim 12 or 13, wherein the centrally located yarn comprises ethylene and at least one olefin.

15. A method of manufacturing a fire-resistant textile material, comprising:

weaving yarn according to any of claims 1 to 9 in both warp and weft directions.

16. The method according to claim 15, wherein the weave is a twill weave.

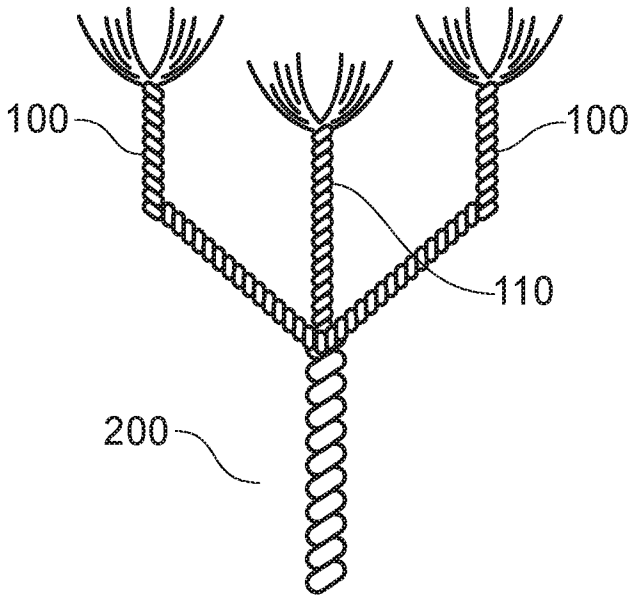

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/051651

A. CLASSIFICATION OF SUBJECT MATTER
INV. D02G3/32 D02G3/44
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2014 208930 A (NIPPON KEORI KK) 6 November 2014 (2014-11-06)	1,2,6,7, 10-13, 15,16
Y	paragraph [0001] paragraph [0006] paragraph [0013] - paragraph [0015] paragraph [0019] - paragraph [0022] paragraph [0033] paragraph [0037] - paragraph [0038] figures 1-3	3,4,8,9, 14

Y	WO 2016/010659 A1 (DRIFIRE LLC [US]) 21 January 2016 (2016-01-21) paragraph [0016] - paragraph [0017] paragraph [0026] paragraph [0060] - paragraph [0061] claims 1,19	8,9

	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 August 2019	03/09/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Humbert, Thomas

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/051651

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2008/097356 A2 (SOUTHERN MILLS INC [US]; TUTTEROW D CRAIG [US] ET AL.) 14 August 2008 (2008-08-14) page 3 page 4, paragraph 3 example 1 figures 1,2	3,4,14
A	US 5 694 981 A (STANHOPE MICHAEL T [US] ET AL) 9 December 1997 (1997-12-09) abstract; figure 2b	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2019/051651

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2014208930 A	06-11-2014	JP 5937633 B2	22-06-2016
		JP 2014208930 A	06-11-2014
WO 2016010659 A1	21-01-2016	AU 2015224518 A1	04-02-2016
		CA 2953336 A1	21-01-2016
		US 2017198423 A1	13-07-2017
		WO 2016010659 A1	21-01-2016
WO 2008097356 A2	14-08-2008	CA 2661685 A1	14-08-2008
		EP 2069571 A2	17-06-2009
		JP 2010502858 A	28-01-2010
		US 2008152888 A1	26-06-2008
		WO 2008097356 A2	14-08-2008
US 5694981 A	09-12-1997	NONE	