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(71) Applicant: **Seyntex NV**
8700 Tielt (BE)

(72) Inventor: **Smissaert, Lieven**
9920 Lovendegem (BE)

(74) Representative: **Eeckhaoudt, Sabine Maria A et al**
Brantsandpatents bvba
Guldensporenpark 75
9820 Merelbeke (BE)

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(54) **Impermeable seams for permeable CBRN clothing**

(57) This invention relates to protective clothing in particular suitable for military use, comprising at least two layers of fabric, a first outer fabric and a second inner fabric, both with a weight of 25 to 400g/m² with the characteristic that the protective clothing is provided with

stitching comprising thread that is oleophobic. In a second aspect, this invention also relates to a method for the production of such protective clothing.

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Description

TECHNICAL FIELD

[0001] This invention relates to the use of a thread whereby no wicking occurs to make the stitching of CBRN clothing impermeable for chemical and/or biological agents. Furthermore, this invention relates to the use of this CBRN clothing with such stitching for protection against chemical and/or biological agents.

[0002] In particular, the invention relates to making stitching in CBRN clothing impermeable against chemical and/or biological agents.

BACKGROUND

[0003] Protective clothing for the military exposed to chemical and/or biological agents is well known. This is the so-called CBRN clothing, which represents clothing for protection against chemical, biological, radiological and nuclear factors. This clothing must be made in such a way that none of these hazardous substances can reach the body or underwear of the relevant persons.

[0004] There are in principle three types of CBRN clothing: air and water vapour impermeable clothing made with a layer of impermeable rubber. This type, however, rapidly builds up a large amount of heat and is uncomfortable. On the other hand, there is also air and water vapour permeable clothing that is very comfortable. Finally, there is also clothing that consists of 2 layers. The first layer is an outer fabric (3) and the second layer is an inner fabric (5). In the inner fabric, a membrane is present that is water vapour permeable, but said chemical and/or biological agents cannot go through. The active component of the membrane is based on active charcoal (4) (powders or fibres) that absorb the chemical and/or biological agents.

[0005] CBRN clothing of the latter type, for example trousers or vests, are made up and show seams in various places where pieces are sewn together. Seams are also found on other places in this protective clothing, for example, in zippers and pockets. These stitched components are known as the faint element in the structure of protective clothing.

[0006] Biological and/or chemical agents, such as mustard gas, are synthetic in nature. They are not only applied in vaporized, but also in liquid phase in modern warfare. Standard sewing threads show a high wicking behaviour. Due to this, chemical and/or biological agents can be easily absorbed through the sewing thread and spread over the thread. This phenomenon ensures that, with contact, the chemical and/or biological agents will reach the inside of the CBRN clothing through the sewing thread in stitching and therefore impair the protection.

[0007] Making stitchings in confectioned protective clothing fully resistant against chemical and/or biological agents is currently not sufficiently achieved with the standard sewing threads.

[0008] Various ways are known to shield these critical places temporarily or permanently against these hazardous substances.

[0009] The obvious technique today to bypass the problem of the stitches through the layers is to produce the inner and outer fabric separately. That way, there is no stitched through thread, which can act as transport means for the warfare agent.

[0010] US6691326 describes the use of a special zipper for protection against chemical and/or biological agents. A special coating is used so that the seams are densely coated.

[0011] In WO2006114122 clothes are made seamlessly, in this case a piece of clothing for the foot, so there is no weakness in the piece of clothing. This is achieved by cutting out of one piece of fabric. Thereafter this piece is welded on the right places.

[0012] EP1725127 describes the use of different laminates to cover stitched seams with an extra layer to thus use the extra layer as seal against chemical and/or biological agents. This technique is described on the use for protective clothing for the lower part of the leg.

[0013] The disadvantage of all solutions that are currently known is that no regular stitching techniques can be used for producing the CBRN clothing without loss of comfort, or without the use of additional materials. Without stitching through the layers, certain clothing such as overalls will be less easy to put on. For that reason it was verified if the conventional stitching techniques could still be used.

[0014] The purpose of this invention is to make the stitching of CBRN clothing impermeable against chemical and/or biological agents. This is achieved by means of a sewing thread that has been treated in such a way that no wicking occurs; hence there is no absorption and spreading of liquids through the sewing thread.

SUMMARY

[0015] For this purpose, the invention provides a piece of protective clothing in particular suitable for military use, comprising at least two layers of fabric, a first outer fabric and a second inner fabric, both with a weight of 25 to 400g/m²

with the characteristic that the protective clothing is provided with stitching comprising thread that is oleophobic.

[0016] The oleophobic thread ensures that no wicking can occur in the stitching and that there is no transport of chemical and/or biological agents by the sewing thread in stitching. This way it is possible to use stitches when making military protective clothing without the need to use any additional materials to protect the stitching against breakthrough and without the loss of comfort.

[0017] In a preferred embodiment, the oleophobic thread comprises fibres selected from the group of polyester, cotton, polyamide, viscose, flax, or mixtures of two or more fibres from this group. More preferably, the thread is composed of fibres from polyester and cotton, preferably between 40-60% and 60-40% polyester-cotton, more preferably in an equal ratio.

[0018] The thread preferably has a weight of 20 to 200 tex, more preferably 30 to 120 tex. In a preferred implementation, the thread has a weight of 50 to 80 tex. The advantage of this implementation is that the thread has a sufficient strength for making the stitches.

[0019] In a second aspect, this invention provides a method for the production of protective clothing, in particular suitable for military use that comprises at least two layers of fabric, characterized in that the protective clothing is provided with stitching comprising thread that has undergone an oleophobic treatment.

DETAILED DESCRIPTION OF THE FIGURES

[0020]

Figure 1 shows a simplified version of CBRN clothing. An assembly seam (1) and a sewn seam (2) can be seen here.

Figure 2 shows a simplified version of a preferred structure of the textile material layers of which CBRN clothing consists. It consists of an outer fabric (3) and an inner fabric (5) on which a membrane is present with active charcoal (4).

Figure 3 shows a simplified version of an assembly seam where a sewing thread (6) is stitched through the different layers (3, 5) of the textile material layers.

Figure 4 shows a simplified version of a sewn seam where a sewing thread (6) is used to stitch an element on the textile layers (3, 5) of material.

Figure 5 shows a simplified version of the stitching of the textile layers of material (3, 5) with sewing thread (6).

DETAILED DESCRIPTION OF THE INVENTION

[0021] In a first aspect, the invention provides a piece of protective clothing in particular suitable for military use, comprising at least two layers of fabric, a first outer fabric and a second inner fabric, both with a weight of 25 to 400g/m² with the characteristic that the protective clothing is provided with stitching comprising thread that is oleophobic.

[0022] The term stitch refers in this invention to a place on the piece of clothing where there is a seam or stitching. The term seam refers in this invention to a place where a connection has been made between different layers of fabric with a sewing thread. The term stitching refers in this invention to a place where a sewing thread only connects an outer and inner fabric.

[0023] In a preferred embodiment of the method according to the invention, stitching occurs through the outer fabric (3) and the inner fabric (5) of CBRN clothing with a thread that has been functionalised in such a way that wicking of chemical and/or biological agents is non-existent in the thread.

[0024] The term wicking refers in this invention to the capillary action of a liquid in a thread. Wicking means the ability of the thread to spread liquid in the thread which comes into contact with the thread.

[0025] This has the advantage that conventional stitching techniques can be used for making the fabrics into CBRN clothing. As a result, there is no loss of comfort and no additional materials are used.

[0026] The purpose of the outer fabric (3) is keeping the chemical and/or biological agents in liquid form away by being water and oil repellent. A fabric can be used for this, on the basis of cotton, cellulose acetate, flax, linen, aramid, polyester, polyamide, polyurethane, viscose, poly(meth)acrylate, polyolefin, polysulfone, polyethersulfone, polyether ether ketone, polyether ketone, polystyrene, poly para-phenylene sulphite, polytetrafluoroethylene, polyvinyl chloride or copolymers thereof and all possible mixtures of aforementioned; preferably cotton, polyester or polyamide and their mixtures are used; most preferably cotton is used.

[0027] The outer fabric (3) has a basic weight that is in the range of 25 to 400 g/m², or preferably in the range of 75 to 300 g/m², or most preferably in the range of 125 to 250 g/m².

[0028] The inner fabric (5) and the membrane (4) are intended to stop the diffused passing of the vapour of chemical and/or biological agents. This is achieved by means of capturing through an adsorption medium which is processed in the membrane. The adsorption medium can be selected from active charcoal, carbon fibres, nano fibres, lime, zeolite and other substances with a high internal surface area; preferably active charcoal or carbon fibres is used, and most preferably active charcoal is used.

[0029] The inner fabric (5) has a basic weight that is in the range of 25 to 400 g/m², or preferably in the range of 50 to 300 g/m², or most preferably in the range of 75 to 200 g/m².

[0030] The membrane (4) with the adsorbing medium has a basic weight that is in the range of 25 to 300 g/m², or preferably in the range of 50 to 275 g/m², or most preferably in the range of 75 to 250 g/m².

[0031] A suitable sewing thread (6) for the stitches is a sewing thread that does not absorb any drops of chemical and/or biological agents and does not show any wicking of these agents. To this end a treated thread can be used based on polyester, cotton, polyamide, viscose, flax and mixtures of two or more of the aforementioned materials, or preferably thread is used that consists of a mixture of polyester/cotton in a ratio between 60/40 and 40/60, or most preferably a thread is used that consists of a mixture of polyester/cotton in a 50/50 ratio.

[0032] The sewing thread has a weight that ranges between 20 and 200 tex, or preferably between 30 and 120 tex, or most preferably between 50 and 80 tex.

[0033] The treatment of the thread must be an oleophobic treatment whereby the thread undergoes a coating via a technique such as extrusion coating, slot coating, foulard coating, roller coating, spray coating, or coating through a bath. The most preferential setup is by coating the thread via immersion through a bath with a fluorocarbon solution, followed by a thermal curing of the thread.

[0034] Immersion takes place in a bath during a period between 10 and 180 minutes, or preferably during a period between 50 and 140 minutes, or most preferably during a period between 80 and 100 minutes. The fluorocarbon solution consists of a concentration between 1 and 400 ml/l, or more preferably a concentration between 5 and 200 ml/l or the most preferential between 20 and 60 ml/l.

[0035] The thread is then dried at a temperature between 50 and 90 °C, preferably at a temperature between 60 and 80 °C or most preferably at a temperature between 65 and 75 °C. This is achieved during a period between 10 and 50 minutes, preferably during a period between 20 and 40 minutes or most preferably during a period between 25 and 35 minutes.

[0036] The thread that is treated that way can undergo an after treatment where the full curing of the fluorocarbon is intended. This curing is achieved by pressing the thread on a hot surface. The curing is achieved at a temperature between 110 and 210 °C, preferably at a temperature between 130 and 190 °C or most preferably at a temperature between 150 and 170 °C. This is done during a period between 1 and 60 seconds, preferably during a period between 5 and 30 seconds or most preferably during a period between 10 and 20 seconds.

[0037] The invention will now be explained further by means of the following example, however, without being limited to this.

[0038] Specific examples of sewing threads are summarised in Table 1.

Table 1

Sewing thread no.	Basic material	Treated with	After treatment
G-01	Polyester/cotton (50/50), 60 tex	-	-
G-02	Polyester/cotton (50/50), 60 tex	Water repellent finish	-
G-03	Polyester/cotton (50/50), 60 tex	Oil repellent finish	-
G-04	Polyester/cotton (50/50), 60 tex	Oil repellent finish	15 sec pressing at 160 °C

- By a water repellent treatment a wax treatment is meant.
- By an oil repellent treatment a treatment is meant whereby the threads are finished with a fluorocarbon solution in a bath.
- An after treatment means that the finished thread comes into contact with a hot sheet of 160 °C for 15 seconds.

[0039] G-01 is a comparative example, a standard polyester/cotton thread that has not been treated.

[0040] The finishing technique to treat the threads G-02 to G-04 is done via a bath coating in the respective solutions.

[0041] Breakthrough of chemical and/or biological agents through the seams

[0042] Three different seams are tested to evaluate the breakthrough. These seams were the assembly seam (Figure 3), the sewn seam (Figure 4) and the stitching (Figure 5).

[0043] The outer fabric (3) that was used, was a cotton fabric of 200 g/m².

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[0044] Two inner fabrics were used, with a different load of active charcoal. Both inner fabrics had a weight of 120 g/m² and consisted of polyester/cotton (50/50). The first inner fabric, AK-01, has a load of active charcoal of 200 g/m². The second inner fabric, AK-02, has a load of 100 g/m² active charcoal.

[0045] The breakthrough is measured by means of a permeation test, the Methyl Red method with mustard gas. In the permeation test, a sample is placed on top of a glass beaker that is filled with a methyl red solution. Drops of 1 µl mustard gas are placed at the top of the test sample. Everything is sealed so that the mustard gas cannot evaporate. The colour change of the Methyl Red reveals if there is breakthrough of the mustard gas through the sample. It is tested for 24 hours. Temperature is kept at 20 °C, the humidity is ambient humidity. If there is no breakthrough after 24 hours, a sufficient resistance is assumed.

[0046] Table 2 shows the results for breakthrough after 24 hours, and this for the seam type assembly seam. X in the Table means that this type of thread in combination with this type of inner fabric does not have breakthrough of mustard gas after 24 hours.

Table 2

Thread type	Inner fabric AK-01	Inner fabric AK-02
G-01		
G-02	X	X
G-03	X	X
G-04	X	X

[0047] For Table 2 applies that both the water and the oil repellent treated threads score sufficient for assembly seams. The mustard gas, and therefore other chemical and/or biological agents, are sufficiently deterred.

[0048] Table 3 shows the results for breakthrough after 24 hours, and this for the seam type sewn seam. X in the Table means that this type of thread in combination with this type of inner fabric does not have breakthrough of mustard gas after 24 hours.

Table 3

Thread type	Inner fabric AK-01	Inner fabric AK-02
G-01		
G-02		
G-03	X	
G-04	X	X

[0049] For Table 3 applies that only G-04 scores sufficient in combination with both inner fabrics for sewn seams. The mustard gas and therefore other chemical and/or biological agents are sufficiently deterred. Thread G-03 scores also sufficient in combination with inner fabric AK-01.

[0050] Table 4 shows the results for breakthrough after 24 hours, and this for stitching. X in the Table means that this type of thread in combination with this type of inner fabric does not have breakthrough of mustard gas after 24 hours.

Table 4

Thread type	Inner fabric AK-01	Inner fabric AK-02
G-01		
G-02		
G-03		
G-04	X	

[0051] For Table 4 applies that only G-04 scores sufficient in combination with inner fabric AK-01 for stitching. The mustard gas and therefore other chemical and/or biological agents are sufficiently deterred.

Wicking behaviour of the threads

[0052] The different threads G-01 to G-04 were visually inspected using ISO 14419. In addition, oil drop number 4 was used, because this displays an equivalent behaviour to mustard gas.

[0053] Both threads G-01 and G-02 absorb the oil drop number 4 directly.

[0054] Thread G-03 also absorbs oil drop number 4, but after a much longer period. Thread G-04 does not absorb oil drop number 4.

[0055] Table 5 shows the speed of the wicking behaviour of oil number 4 in the different threads.

Table 5

Sewing thread no.	Basic material	Absorption of oil drop	Wicking speed
G-01	Polyester/cotton (50/50), 60 tex	immediately	2.1 meter/h
G-02	Polyester/cotton (50/50), 60 tex	immediately	0.6 meter/h
G-03	Polyester/cotton (50/50), 60 tex	after 10 minutes	0.001 meter/h
G-04	Polyester/cotton (50/50), 60 tex	> 1 hour	<0.001 meter/h

[0056] It is clear that thread type G-04 exhibited no absorption and wicking behaviour. This ensures that there is no breakthrough of chemical and/or biological agents through the seam of the CBRN clothing.

Claims

1. Protective clothing suitable for military use, comprising at least two layers of fabric, a first outer fabric and a second inner fabric, both with a weight of 25 to 400g/m² **characterized in that** the protective clothing is provided with stitching comprising thread that is oleophobic.
2. Protective clothing according to claim 1, whereby the oleophobic thread consists of fibres selected from the group of polyester, cotton, polyamide, viscose, flax, or mixtures of two or more fibres from this group.
3. Protective clothing according to claim 1 or 2, whereby the thread has a weight of 20 to 200 tex, preferably from 30 to 120 tex.
4. Protective clothing according to claim 3, whereby the thread has a weight of 50 to 80 tex.
5. Protective clothing according to any of claims 1 to 4, whereby the oleophobic thread comprises fibres of polyester and cotton, preferably between 40-60% and 60-40% polyester-cotton.
6. Protective clothing according to any of claims 1 to 5, whereby the thread is provided with fluoro-carbon.
7. Protective clothing according to any of claims 1 to 6, whereby the thread forms the assembly seam, sewn seam and/or the stitching.
8. Protective clothing according to any of claims 1 to 7, whereby the inner fabric comprises a membrane with an absorbing medium, **characterized in that** the membrane has a weight of 25 to 300 g/m².
9. Protective clothing according to claim 8, **characterized in that** the absorbing medium is active charcoal.
10. Protective clothing according to any of claims 1 to 9, **characterized in that** the outer fabric is water and oil repellent.
11. Protective clothing according to any of claims 1 to 10, **characterized in that** the outer fabric has a weight of 75 to 300 g/m², more preferably a weight of 125 to 250g/m².
12. Protective clothing according to any of claims 1 to 11, **characterized in that** the inner fabric has a weight of 50 to 300 g/m², more preferably a weight of 75 to 200 g/m².

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13. Protective clothing according to any of claims 8 to 12, **characterized in that** the membrane has a weight of 50 to 275 g/m², more preferably a weight of 75 to 250 g/m².
- 5 14. Method for the production of protective clothing, in particular suitable for military use that comprises at least two layers of fabric, **characterized in that** the layers of fabric/protective clothing is provided with stitching comprising thread that has undergone an oleophobic treatment.
- 10 15. Method for making protective clothing according to claim 14, whereby the thread is provided with a coating with a fluoro-carbon solution.

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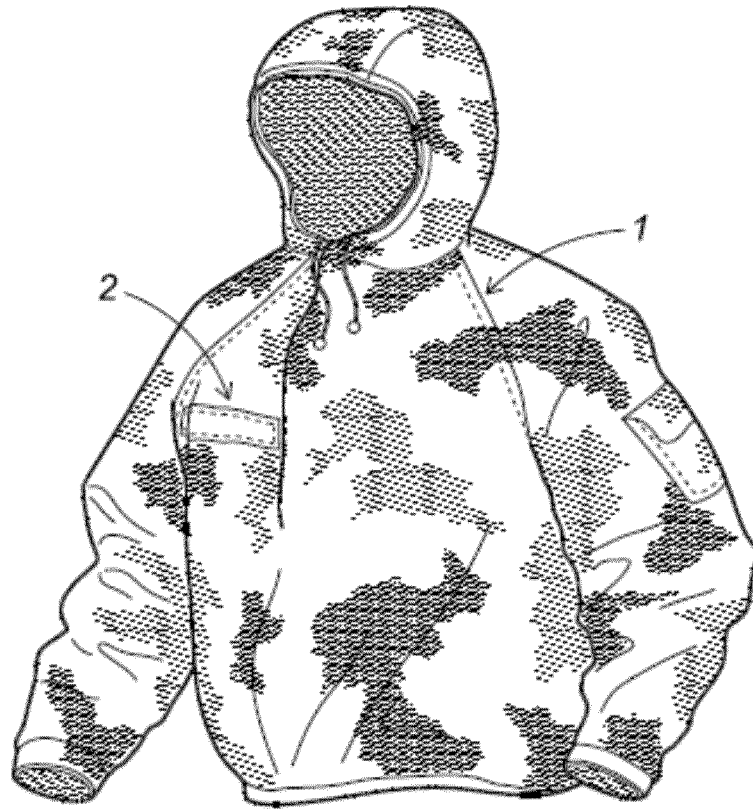


Fig. 1

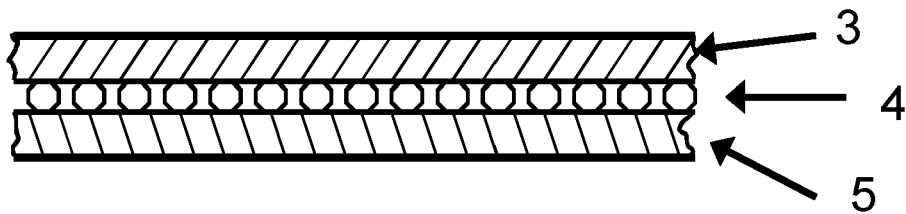


Fig. 2

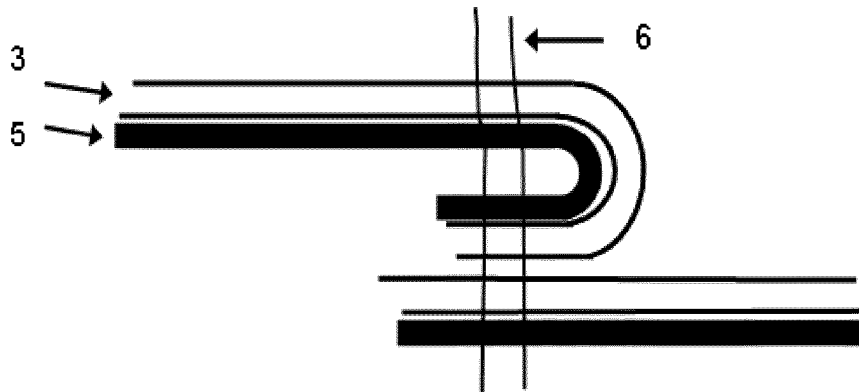


Fig. 3

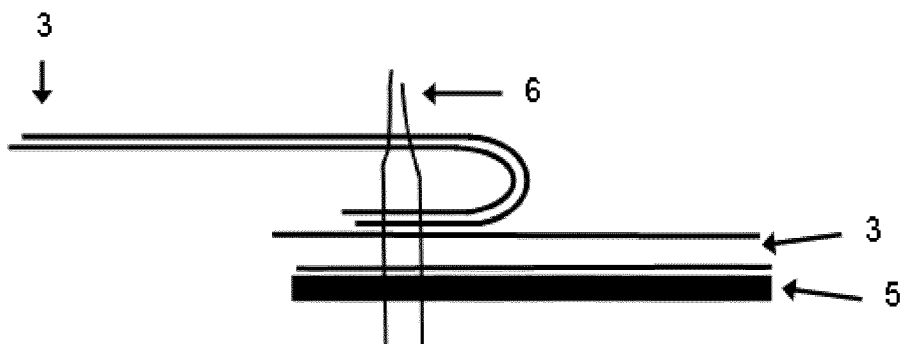


Fig. 4

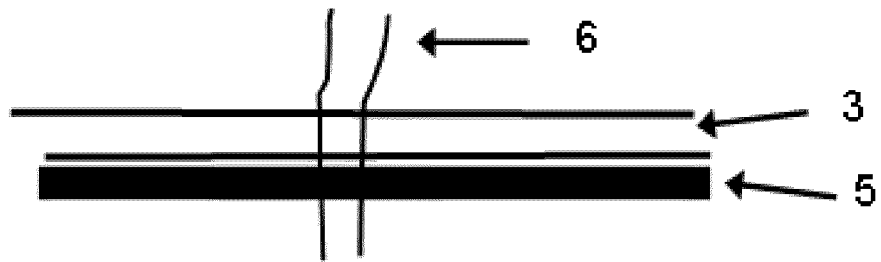


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
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X	US 2011/123757 A1 (HOWLAND CHARLES A [US]) 26 May 2011 (2011-05-26)	1-15	INV. A62D5/00
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 26 March 2013	Examiner Dalkafouki, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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