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(12) # EUROPEAN PATENT APPLICATION

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(54) **A compound fabric made up of single or ply yarns of conventional textile fibers interlaced, according to a rectangular pattern, with single or ply yarns at least partially mixed with a carbon filament, possessing shielding properties against electromagnetic waves.**

(57) Into a fabric having single or two or more ply yarns of any kind of fiber, whether natural or man-made, in the warp and weft, arranged according to any type of weave, are interlaced, according to a preestablished alternation ratio, single or ply yarns which are at least partially mixed with a carbon filament so that said carbon filament forms in the fabric an orthogonal grid similar to a network having square or rectangular meshes, thus obtaining an effective shield against electric fields induced by alternating current particularly in the frequency range of from 50 to 1000 Hz.

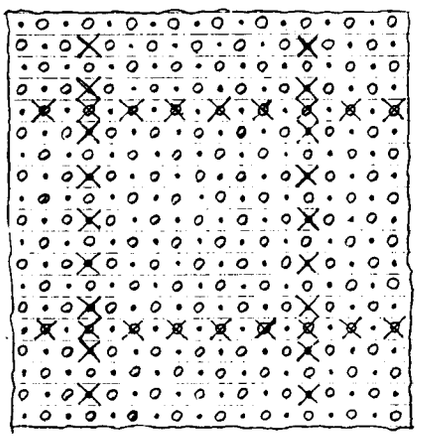

FIG.1

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The present invention concerns a compound fabric made up of a single (one-ply) yarn (hereinafter also called "single") and ply yarns of conventional textile fibers of any kind and of any yarn count whatsoever, in the warp and weft(or filling) of which are interlaced, according to pre-set alternation ratios and with an orthogonal reticular pattern, singles or ply yarns at least partially mixed with a carbon filament. Within the context of the instant disclosure the term "carbon filament" is used to identify a carbon filament made up of one or more strands.

It is an object of the instant invention to provide a fabric which, while preserving the best possible appearance and modelling characteristics, possesses shielding properties against electric fields generated by the presence of alternating currents.

According to the invention, the problem can be solved by inserting, in a predetermined manner, according to an orthogonal reticular pattern with specific, not necessarily equal ratios, in the warp and in the weft, one or more singles or ply yarns mixed, at least partially, with a carbon filament, said singles or ply yarns being inserted between the single yarn or ply yarns of the basic fiber(s) of the fabric.

A cloth made of carbon filaments only, arranged warp-wise and weft-wise,thus having a 1:1 ratio of alternation, was subjected to shielding effectiveness tests against a 60 Hz electric field of the U.S. power supply network.

The measurements made at a Laboratory of the National Institute of Standards and Technology (NIST) (formerly National Bureau of Standards) by placing the cloth sample, in one layer only, in an electric field established with two parallel metal plates, have indicated an average reduction of the electric field by a factor of 30 dB and when the cloth was folded the field decreased by an additional 45%.

Similar measurements were performed in Italy at a Public Laboratory on one layer of the same cloth made of carbon filaments only, using a TEM (Transverse Electromagnetic Mode) cell which allows to establish a plane wave electric field, orthogonal to the surface of the test material. With said cell, located in an anecoic chamber in order to eliminate reflections which can affect the precision of the measurements, there resulted a reduction of the electric field by a factor of 32 dB at 50 Hz, which is perfectly consistent with the NIST measurements. Said factor decreases to 2.5 at the frequency of 10^5 Hz and to 1.4 at the frequency of 10^6 Hz, whereas at very high frequencies such as 10^9 and 10^{11} Hz the shielding effectiveness is practically nihil; these latter frequencies are present, e.g. in the microwave ovens.

A cloth of this kind, although its carbon filaments are light-weight and possess flexibility comparable to singles or ply yarns of common natural or man-made textile fibers with higher yarn count, could be suitable for manufacturing everyday clothing to the detriment of appearance, workability and of cost.

By spacing out, within certain proportions, the insertion of the carbon filaments, coupled with singles or ply yarns of the prevailing fiber(s) of the basic fabric, and thus interlacing said mixed elements according to suitable ratios of alternation within a proportionality range of from 1 out of 2 to 1 out of 100, so as to form an orthogonal grid in fabrics of any kind of weave, fabrics have been made having appearance and softness to the touch unvaried over the original fabric. No workability problem has arisen on the loom during weaving, or when tayloring, whereas the cost increase turned out to be very low.

A sample of fabric according to the instant invention was subjected to shielding effectiveness measurements at the same Italian Public Laboratory.

Hereinafter are reported the results of the measurements at 50 Hz using a single layered cloth in Batavia weave,i.e. a 2-up and 2-down twill weave.In particular, into the fabric was inserted a woollen single mixed with a carbon filament, 1 out of 9, i.e. one every eight woollen singles of the basic fabric. In this case, the yarn mixed with the carbon filament formed an orthogonal grid symmetrical in both directions, having the appearance of a netting with square meshes.

The reduction of a lab-made electric field is highlighted by the following values:

- Electric field in the absence of the sample

  E1 = 463 V/m

- Electric field in the presence of one layer of the sample

  E2 = 2.8 V/m

- Ratio E1/E2 = 165.3,

which corresponds to a reduction factor of 44.3 dB.

The shielding effectiveness was then measured in the open near a high voltage electric line at 50 Hz placing the same inventive fabric on a dielectric stand which allows the insertion in its inner part of the measuring probe, thus completely shielding the probe against the external electric field. The values of the electric field E'1 and E'2 of the blank and of the sample of cloth were:

E'1 = 6000 V/m
E'2 = 32 V/m

ratio E'1/E'2 = 187.5,
which corresponds to a reduction factor of 45.4 dB.

This data confirms the shielding effectiveness measurements performed in the laboratory using a TEM cell.

The electric field reduction factors, which turned out to be equal to, or better than, the ones relating to a fabric wholly made of carbon filaments, would appear to be due to the orthogonal reticular layout of the carbon filaments,which in this way build up a sort of fixed lattice or network inside the fabric.

According to the instant invention, the meshes of the net ought not necessarily to have equal sides,i.e.they may be rectangular rather than square, with the longer side arranged either warpwise or weftwise.

The alternation ratio of the singles or of the ply yarns mixed with one or more carbon filaments varies according to the weight per square meter of the fabric and thus it depends on the yarn count of the basic yarn, either single or ply, of which the fabric is made up; said alternation ratio, as already mentioned, can vary within the range of 1 out of 2 to 1 out of 100.

Exemplarily, the preferred range of the alternation ratio for a fabric made of a two-ply yarn of wool fiber having a yarn count of 2/80 equal to 250 dTex, lies between 1 out of 3 and 1 out of 16, whereas in the case of a yarn count of 2/150 equal to 133 dTex, the alternation ratio shall preferably vary from 1 out of 16 to 1 out of 25; if the yarn count is of 1/14, or 715 dTex, it shall preferably vary from 1 out of 2 to 1 out of 8;with a yarn count of 2/200,or 100 dTex, said ratio shall preferably vary from 1 out of 20 to 1 out of 40; for a yarn count of 2/300, or 66 dTex, it shall preferably vary from 1 out of 35 to 1 out of 70.

The instant invention shall now be further disclosed in detail by the following embodiments relating to compound fabrics, with the understanding that the instant disclosure is to be considered an exemplification of the principles of the invention and is not intended to limit the same; which embodiments are illustrated in the enclosed drawings wherein:

Fig.1 is a schematic representation of a fabric made of a single yarn or ply yarn of wool or of any other fiber arranged in plain weave, wherein are interlaced,according to a symmetric warp/weft orthogonal reticular pattern and with an alternation ratio of 1 out of 10, elements made of single yarn or ply yarn of wool or of any other fiber mixed with a carbon filament, one every nine single o ply yarns of wool or of any other fiber.

Fig.2 is a schematic representation of a compound fabric according to the instant invention made of a single or ply yarn of wool or of any other fiber, in twill weave, wherein are interlaced, according to a symmetric warp/weft orthogonal reticular pattern and with an alternation ratio of 1 out of 12, elements made of single or ply yarn of wool or of any other fiber mixed with a carbon filament, one every eleven single or ply yarns of wool or of any other fiber.

Fig.3 is a schematic representation of another compound fabric of the invention made of a single or ply yarn of wool or of any other fiber, in Batavia twill weave, wherein are interlaced, according to a symmetric warp/weft orthogonal reticular pattern and with an alternation ratio of 1 out of 9, elements made of a single or ply yarn of wool mixed with a carbon filament, one every eight single or ply yarns of wool or of any other fiber.

Fig.4 is a schematic representation of a compound fabric of the invention made of a single or ply yarn which can also comprise fibers of different kind, in Batavia twill weave, wherein are interlaced, according to an asymmetric orthogonal reticular pattern, i.e. having a different alternation ratio in the warp over the weft, elements comprising a single or a ply yarn, also of different fibers, mixed with a carbon filament.

With reference to the figures, the elements of the weave for any kind of fabric, when comprising the basic fibers only, are identified by a dot in the warp and by a small circle in the weft respectively, whereas when they comprise the same elements at least partially mixed with one or more carbon filaments the dots and/or small circles bear a cross on top.

The figures represent one of the surfaces of the fabric, i.e. the visible warp or weft elements, e.g. on the right side of the fabric.

The fabrics of the invention can comprise any kind of fiber either natural or man-made, such as e.g. wool, cotton, linen, kemp, rayon, Terylene, Nylon and so forth, and mixtures thereof; the weave can be of any kind, from the most simple, i.e. plain weave, to the more complex ones, such as e.g. Batavia twill weave or twill weave, satin weave and the like.

In general, the singles or ply yarns,two-ply,three-ply and so on, of the various kinds of basic fibers, can be of any number or size whereas the number or size of the carbon filaments, which is usually very small, varies at the most within the range of from 20 to 70 dTex.

In the attached drawings the warp is represented vertically whereas the weft is represented horizontally.

Fig.1 illustrates by way of example an inventive fabric made of wool singles as the warp and weft yarn, in plain weave, wherein each warp and weft element goes, in repetitive manner, alternatively, over and under the respective weft and warp element.

Into this fabric is interlaced, be it in the warp, be it in the weft, a mixed yarn comprising a wool single plied with a carbon filament, with a recurring alternation ratio of 1 out of 10, i.e. with a yarn having a carbon filament,as described above, every nine pure wool singles. Each wool single in this case has a yarn count of 250 dTex, whereas the carbon filament has a count of 27 dTex.

One further example amongst the very many that can be conceived by varying the kind and the count of the basic, single or ply yarn of the fabric, the type of weave, the alternation ratio of the elements mixed with carbon filaments, is illustrated in Fig.2.

In this figure a wool cloth is shown made of a 2/80 ply yarn (250 dTex) in the warp and of a single yarn of the same number in the weft, with an alternation ratio of 1 out of 12, with a symmetric pattern in the warp and in the weft, a twill weave, wherein the weft, in repetitive manner, goes over one warp and under two warp yarns. The mixed elements comprise a wool single plied with a 30 dTex carbon filament in the weft and a two-ply wool yarn plied with a 30 dTex filament in the warp.

In Fig.3 is shown, by way of example, an inventive cloth having as a basic fiber a wool yarn and a Batavia twill weave, wherein each warp and west element, in repetitive manner, goes over two and under two respective filling and warp elements.

In the fabric having the same weave, which was used for the tests of shielding effectiveness against the electric field, in the laboratory as well as in the open, as already described, is interlaced in a symmetric orthogonal reticular pattern and with an alternation ratio of 1 out of 9, both in the warp and in the weft, a mixed element comprising two wool singles plied with a carbon filament in the warp and a mixed element comprising a wool single plied with a carbon filament in the weft.

In Fig.4 is illustrated, by way of example, a cloth comprising plied yarns of two different kinds of fiber with a Batavia twill weave already shown in the Example of Fig.3, wherein are interlaced according to an orthogonal reticular pattern, elements mixed with a carbon filament, viz. with an alternation ratio of 1 out of 12 in the warp and 1 out of 16 in the weft, i.e. one every 11 plied yarns of two different fibers in the warp and one every 15 plied yarns in the weft, as indicated above.

The basic elements of the cloth are two-ply yarns, one being a wool single and the other a Terylene yarn. The mixed elements contain a 27 dTex carbon filament plied with the wool single, which in turn is plied with the Terylene single.

The orthogonal pattern of the grid formed by said plied yarns mixed with a carbon filament develops, in this case, rectangular meshes, having their larger side in the direction of the warp, rather than square meshes as in the preceding figures.

In the fabrics, illustrated in the figures, each single of the basic fiber may vary, in the case of wool, from 60 dTex to 250 dTex, whereas in the case of two or more-ply yarns, the yarn count may vary from 150 to 700 dTex, and in turn the carbon filament mixed to a single or plied yarn of the basic fiber(s) of the fabric preferably varies from 20 to 40 dTex.

As already mentioned, the alternation ratio of the singles or the ply yarns mixed with a carbon filament may vary between 1 out of 2 and 1 out of 100,preferably within the range of from 1 out of 3 to 1 out of 70.

What has been stated in general applies also to fabrics wherein the basic fiber is other than wool, viz.all and any natural, man-made fibers, and also to fabrics comprising not only a sole homogeneous fiber of any kind but also to fabrics of basic fibers mixed in the very many possible combinations of two or more different types, in the most various types of weave.

As a result of the surprising properties of shielding effects against electric fields induced by any source in the frequency range especially from 50 to 1000 Hz, the inventive fabric acquires true and proper ecological features.

Although the invention has been illustrtaed and described in detail with reference to the preferred embodiments, the skilled artisans will have no problem in modifying patterns, weaves or other details without departing from the scope of protection of the invention as defined in the appended claims.

Claims

1. A compound fabric for making ready-made articles, in particular articles of clothing, comprising warp and weft yarns, however interlaced in the weave pattern, said yarns comprising a single yarn or two-or-more-ply yarns of any kind of fiber, whether natural or man-made,characterized by the fact that in the warp and in the weft of the basic fabric are interlaced, according to a preestablished alternation ratio, single yarns or ply yarns which are at least partially mixed with a carbon filament so that said carbon filament forms in the fabric an orthogonal grid similar to a network constituting a shield against the electric field induced

by alternating currents especially in the frequency range of from 50 to 1000 Hz.

2. A fabric according to claim 1, characterized by the fact that said single or ply yarns,which are at least partially mixed with a carbon filament, are interlaced, according to an alternation ratio of from 1 out of 2 to 1 out of 100 in the warp and in the weft of the fabric, preferably in a ratio of from 1 out of 3 to 1 out of 70,viz. a single or a ply yarn mixed with a carbon filament from one to one to one every ninetynine, preferably from one every two to one every sixtynine single or ply yarns of the basic fiber of which the fabric is made.

3. A fabric according to any of claim 1 or 2,characterized by the fact that the carbon filament has a yarn count in the range of from 20 to 70 dTex,preferably from 20 to 40 dTex.

4. A fabric according to any of claims 1 to 3, characterized by the fact that said single or ply yarns, which are at least partially mixed with a carbon filament, are interlaced according to an alternation ratio which is the same in the warp as in the weft of the basic fabric.

5. A fabric according to any one of claims 1 to 3, characterized by the fact that said single or ply yarns, which are at least partially mixed with a carbon filament, are interlaced according to an alternation ratio which is different in the warp from that of the weft of the basic fabric.

6. A fabric according to one or more of claims 1 to 5, characterized by the fact that the basic fabric comprises single or homogeneous ply yarns, whether natural or man-made, or it comprises two or more-ply yarn fibers of different kind, both in the warp and in the weft, into which single or ply yarns are interlaced the single or ply yarns mixed with a carbon filament.

7. A fabric according to one or more of claims 1 to 5, characterized by the fact that in the case of basic wool fabric the wool singles have a yarn count of from 60 to 250 dTex whereas the wool ply yarns have a yarn count of from 150 to 700 dTex.

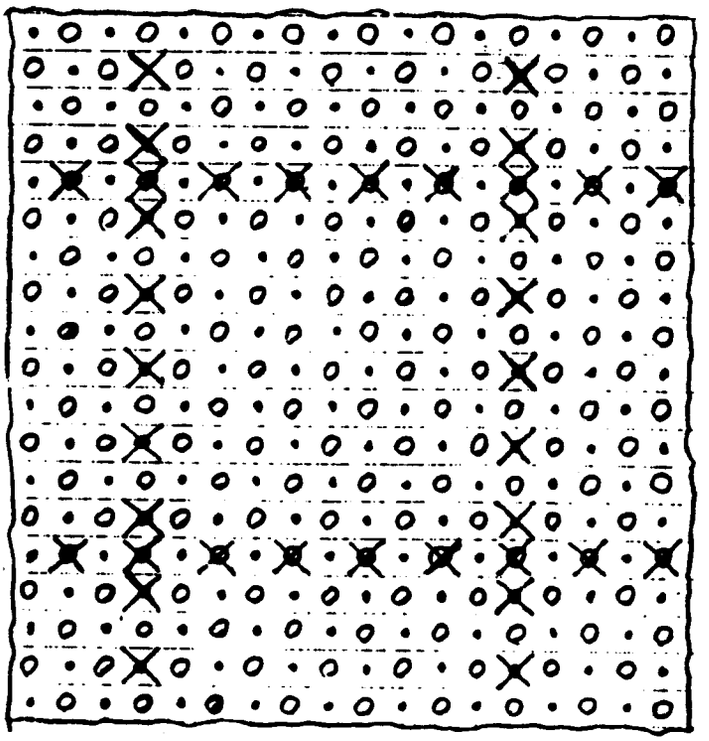

FIG.1

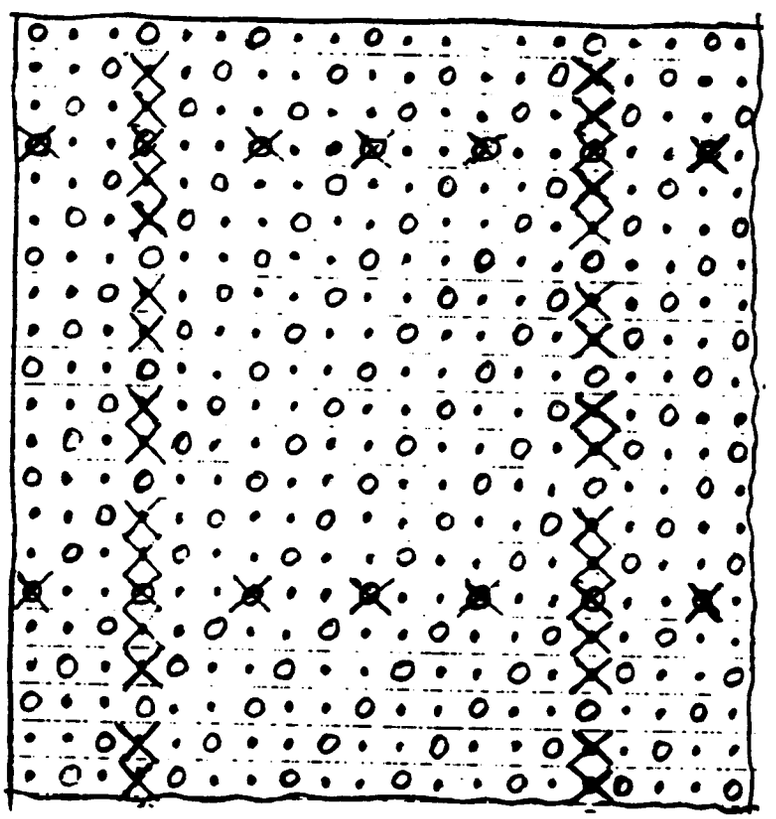

FIG.2

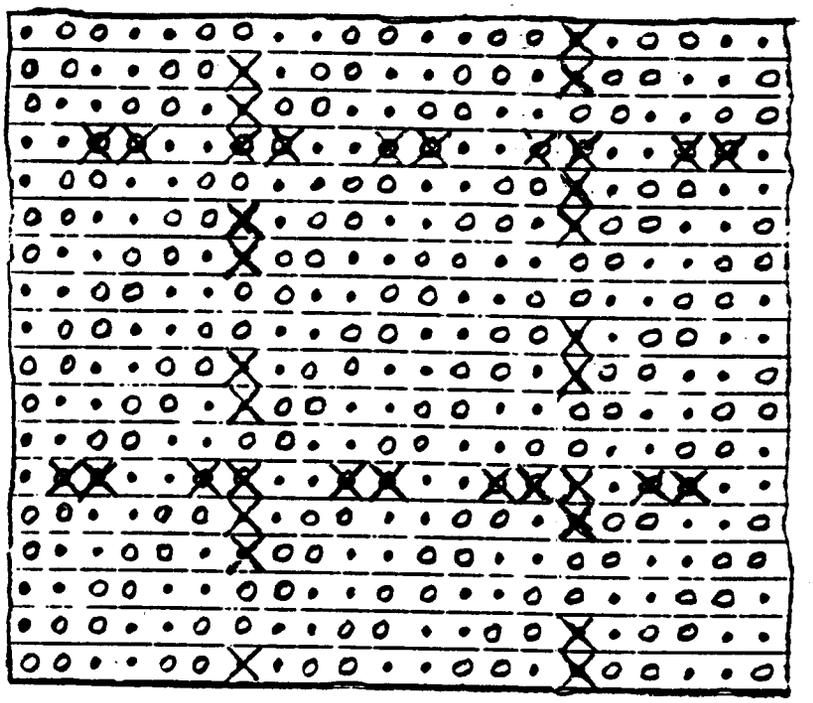

FIG.3

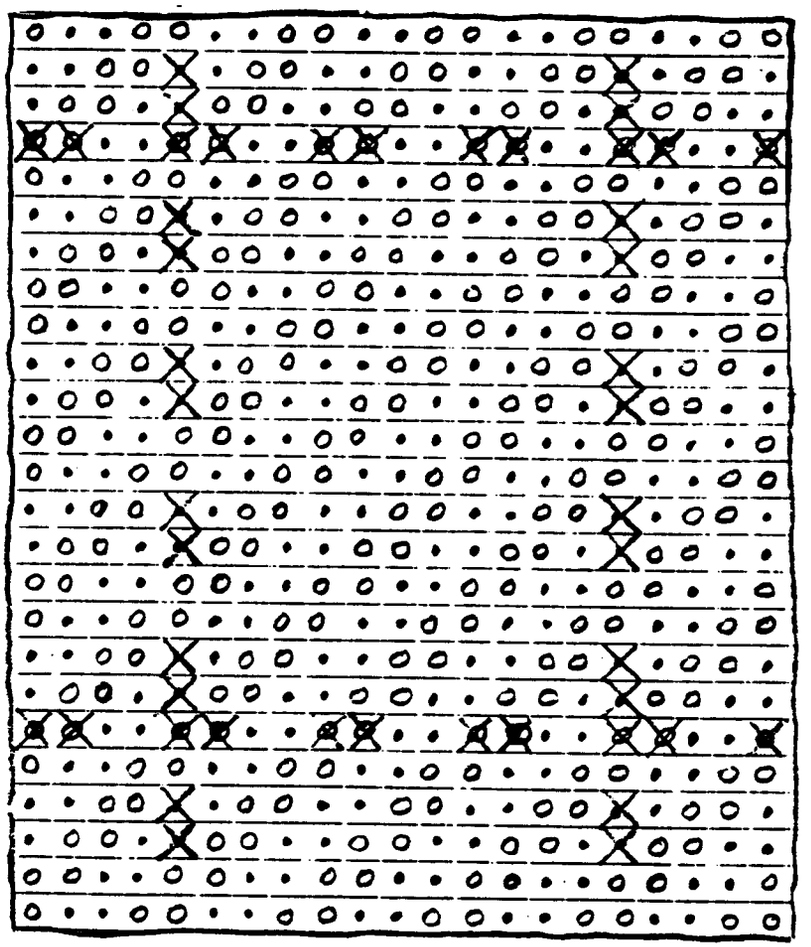

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 5300

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y	WO-A-85 00556 (STERN) * abstract * * column 8, paragraph 1; figure 1 *	1,2,4,5	D03D15/00
Y	WO-A-86 03050 (RAYCHEM) * claim 1 *	1,2,4,5	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 August 1994	Boutelegier, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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