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(54) **Security device, preferably a security thread, comprising characters being visually readable as well as magnetic characteristics, and method of producing the same**

Sicherheitsvorrichtung, vorzugsweise, ein Sicherheitsfaden, bestehend aus visuell lesbaren Zeichen sowie magnetischer Eigenschaften, und Verfahren zu ihrer Herstellung

Dispositif de sécurité, de préférence, un fil de sécurité, comprenant les caractères lisibles visuellement ainsi que des caractéristiques magnétiques, et la méthode pour sa fabrication

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Description

[0001] The present invention relates to a security device according to the preamble of claim 1 and to a method according to the preamble of claim 6. The security device preferably is a security thread having visible negative characters or scripts as well as a magnetic characteristic. The security thread can be incorporated into a document such as a banknote.

[0002] Security threads being partially or completely incorporated into a paper substrate of a banknote during the manufacturing process of the paper substrate are commonly used security devices for the check of the authenticity of the banknote.

[0003] One of those conventional security threads is used in EURO banknotes. For the realisation of such a security thread, three methods are applied in combination which have the following characteristics:

[0004] First, a method of forming negative characters and/or scripts in a thorough metal layer is used, for example by first applying a basis layer of pure aluminium on a polyester substrate so that the aluminium abuts with one surface thereof on the polyester substrate, and then by a demetallisation or by stripping off aluminium parts from the aluminium basis layer so as to form recessed characters or scripts as a negative. These characters or scripts are called "negative characters or scripts" throughout this specification. By visually checking those characters and/or scripts against the backlight, they appear transparent and are thus readable.

[0005] The presence of the metallic basis may be detected by using a capacitive or inductive circuit.

[0006] Second, the conventional security threads comprise magnetic characteristics in the so-called IMT-format. The IMT-format is realised by depositing surfaces having modulated lengths and a constant thickness, with the length of one single module being constant and defined as larger than zero. These security threads are developed and patented by the Bank of England.

[0007] Third, the security threads comprise a combination of metallic and magnetic characteristics as a single security thread.

[0008] For developing and manufacturing a security thread having the above-mentioned characteristics, apart from chemical and physical know-how, high-end and cost-expensive manufacturing methods are required, since a corrosion problem may occur when a security thread having magnetic characteristics on a metallic basis is introduced into an aqueous or wet solution conventionally used for paper manufacture. This corrosion may lead to a loss of the magnetic and/or metallic characteristics.

[0009] Further, the water used for paper manufacture sometimes has a degraded quality, is chlorinated and thereby complicates the manufacture of security threads.

[0010] Another example of a conventional security thread is disclosed in EP-0 516 790 B1 and shown in Fig. 3. Here, the conventional security thread comprises a

transparent substrate, a metallic layer such as a layer of pure aluminium having negative characters 30a incorporated therein, and a magnetic layer 50 arranged over or under the metallic layer 10, with the geometrical arrangement of the magnetic layer 50 allowing the negative characters 30a to be exposed (in this specification, the terms "over" and "under" refer to opposite directions).

[0011] The production method of such a security thread comprises a step of printing an activatable ink on the substrate, a step of applying a metallic layer on the printed side of the substrate, and a step of activating the ink so as to remove the ink together with the metal deposited thereon, thereby forming recesses in the metallic layer. Thus, the negative characters are obtained.

[0012] It is an object of the present invention to provide a resistant security thread comprising characters being visible against the backlight as well as areas having coded magnetic characteristics, and an inexpensive method for manufacturing the same.

[0013] This object is solved by the inventive security device having the features of claim 1 or the method for manufacturing the same having the features of claim 6.

[0014] Preferably, a cover layer is directly arranged over the magnetic code layer so as to protect and smoothen the magnetic code layer.

[0015] Preferably, a heat-bondable glue or coating layer is provided on the side of the substrate opposite to the magnetic code layer and/or on the side of the cover layer opposite to the magnetic code layer for facilitating the incorporation of the security device into a document like a banknote.

[0016] Preferably, the printed ink layer, the support layer and/or the cover layer are made of a grey colour nitroacryl-soluble, resin-based ink containing less than 5 % of aluminium powder. Thus, the security device has an outer appearance like a metallic thread, but due to the neglectable aluminium part of the ink, the security device has no metallic background owing to a lack of electrical or heat conductance.

[0017] Preferably, the magnetic code layer is a printed layer of a magnetic ink which enables an easy manufacture of the magnetic code layer.

[0018] Preferably, the method further comprises the step of printing a cover layer over the magnetic code layer.

[0019] Preferably, the method further comprises the step of arranging a heat-bondable glue or coating layer on the side of the substrate opposite to the magnetic code layer and/or on the side of the cover layer opposite to the magnetic code layer.

[0020] Preferably, the printed ink layer, the support layer and/or the cover layer are printed by means of a grey colour ink, preferably a nitroacryl-soluble, resin-based ink containing less than 5 % of aluminium powder.

[0021] Preferably, the step of printing the printed ink layer uses the corona phenomenon.

[0022] Other aspects and advantages of the present invention will be apparent from the following description

in connection with the figures which show a preferred embodiment of the present invention.

Fig. 1 shows a schematic plan view of a security device according to an embodiment of the present invention;

Fig. 2 shows a schematic cross-sectional view of the security device shown in Fig. 1; and

Fig. 3 shows a schematic cross-sectional view of a conventional security thread.

[0023] As a system for making an inventive security device such as a security thread 1 for being incorporated in a document such as a banknote (not shown), a conventional intaglio printing machine (not shown) may be used, as is, for instance, employed for the printing of a flexible packing material.

[0024] The configuration of the inventive security thread 1 and manufacturing method are explained in connection with Figs. 1 and 2, where schematic plan and cross-sectional views of the security thread 1 are shown.

[0025] The security thread 1 is built up by a substrate which is preferably a transparent polyester substrate 2.

[0026] On the substrate 2, a printed ink layer 3 is arranged which has negative characters or scripts 3a which appear transparent when visually checking them against the backlight.

[0027] For printing, preferably a nitroacryl-soluble, resin-based ink containing less than 5 % of aluminium powder is applied under 52 dyne by virtue of the corona phenomenon. Since the ink contains a neglectable part of aluminium therein, the ink neither conducts electricity nor heat. Preferably, the ink is a grey or silver colour ink.

[0028] It is to be noted that the printed ink layer 3 is not completely covered by the characters or scripts 3a so that there are free areas 3b which are sufficient for arranging a magnetic code adjacent to the characters or scripts 3a which will be applied in a later step.

[0029] Within the free areas 3b directly above the printed ink layer 3, there is preferably a support layer 4. It is to be noted that the support layer 4 is arranged partially only within the free areas 3b adjacent to the scripts or characters 3a so that the characters or scripts 3a and the support layer 4 are arranged alternately in a longitudinal direction of the security thread 1, and the characters or scripts 3a are not covered by the support layer 4.

[0030] Preferably, the support layer 4 is also printed by a grey colour nitroacryl-soluble, resin-based ink containing less than 5 % of aluminium powder.

[0031] Directly above the support layer 4, a magnetic code layer 5 is arranged. Similarly to the support layer 4, the magnetic code layer 5 is arranged partially only within the free areas 3b between the characters or scripts 3a.

[0032] The magnetic code layer 5 is preferably formed by first embossing recesses in a surface of the support

layer 4 opposite to the printed ink layer 3 by means of roll embossing (not shown). That is, by roll embossing, a plurality of recesses having different depths are formed in the support layer 4 so as to create a predetermined signal sequence where, for instance, the recesses representing the binary "1" have a depth of 100 μm , whereas the recesses representing the binary "0" have a depth of 50 μm .

[0033] After the support layer 4 has been embossed, a magnetic ink is directly applied on the embossed surface of the support layer 4. In this case, in the recesses having a depth of 100 μm , twice the amount of the magnetic ink can be accommodated as compared to the recesses having a depth of only 50 μm . For instance, when the magnetic ink is dried, the final thickness of the magnetic ink in the recesses having a depth of 100 μm may be 10 μm , whereas the final thickness of the magnetic ink in the recesses having a depth of 50 μm may be 5 μm .

[0034] As a result, the magnetic code layer 5 comprising different thicknesses of the dried magnetic ink provides the signal sequence which can be read, for instance, by means of a capacitive or inductive circuit (not shown).

[0035] Directly above the magnetic code layer 5, there is preferably printed a cover layer 6 of ink. Similarly to the support layer 4 and the magnetic code layer 5, the cover layer 6 is arranged partially only within the free areas 3b between the scripts or characters 3a. The cover layer 6 provides a protection and also a plain surface over the magnetic code layer 5, since the magnetic code layer 5 itself may have an uneven surface when the magnetic ink is dried.

[0036] Preferably, the cover layer 6 consists of a grey colour nitroacryl-soluble, resin-based ink containing less than 5 % of aluminium powder like the printed ink layer 3 or the support layer 4.

[0037] In the end, on the side of the substrate 2 opposite to the magnetic code layer 5 and/or on the side of the thread 1 opposite to the substrate 2, a heat-bondable glue or coating layer 7 can be applied and can be reactivated during the step of the paper manufacture for the purpose of incorporating the thread 1 in the paper (not shown).

[0038] A thus produced thread 1 can be processed in any paper mills under any methods of manufacturing, for instance in a step for introducing the thread 1 into the paper.

[0039] In case of a processing under the so-called windows technology before printing the heat-bondable glue or coating layer 7, the polyester bobbin (not shown) of the polyester substrate can be coupled with another polyester.

[0040] The security thread 1 according the present invention offers the following advantages.

[0041] The optical features of the security thread 1, that means the negative characters or scripts 3a being visually readable, are printed by use of a conventional grey colour ink having a small amount of aluminium pow-

der (less than 5 %), while the conventional thread is produced by applying a thorough aluminium-layer on a polyester substrate and then by stripping off a part of the aluminium by means of a demetallisation so as to form a negative character. Thus, the production costs of the security strip according to the present invention are reduced since the conventional, expensive steps for the metallisation and the demetallisation are omitted.

[0042] For example, while the conventional security thread of the EURO banknote requires at least two high-end apparatuses for the metallisation and the demetallisation, the security thread 1 according to the present invention can be produced by using the conventional rotary press roller (not shown) having different sections and a printing width of 1600 mm, whereas the printing width of the conventional thread in the EURO banknote having an aluminium layer, which must be subjected to a demetallisation process, is 800 mm. Thereby, the costs are further remarkably reduced.

[0043] Due to the printing width of 1600 mm according to the present invention, all necessary processing steps can be implemented in the same production assembly, and due to the double printing width of 1600 mm as compared with the conventional printing width of 800 mm, twice the production amount can be realised.

[0044] Furthermore, the grey colour ink of the printed ink layer 3 neither conducts electricity nor heat due to the neglectable amount of aluminium therein so that the printed ink layer 3 forms no metallic background. Thereby, the security thread 1 is resistive against even the worst environment conditions during the paper manufacture process.

[0045] The magnetic code layer 5 of the security thread 1 according to the present invention has, on the one hand, an even surface due to the cover layer 6 and, on the other hand, different thicknesses of the magnetic ink due to the provision of the support layer 4 having different embossed recesses. For example, the recesses representing the binary "1" are twice as deep as the recesses representing the binary "0". Since the binary "0" can be clearly differentiated as compared with the IMT-format, where the binary "0" is characterised by a complete lack of a magnetic characteristic, the security thread 1 according to the present invention can be at least 30 % longer.

[0046] As a matter of course, the above embodiment can be altered into many variations within the scope of the invention.

[0047] Also, the cover layer 6 may be omitted so that the magnetic code layer 5 is directly covered by the heat-bondable glue or coating layer 7, for instance.

[0048] The support layer 4 obtains different embossed recesses by means of the roll embossing, however the different recesses may also be formed by another device or method, such as an appropriate printing device and method.

[0049] In the above embodiment, the support layer 4 and the cover layer 6 are arranged only in the free areas 3b adjacent to the characters or scripts 3a, but it is con-

ceivable that the support layer 4 and/or the cover layer 6 have sufficient transparency to be arranged over the characters or scripts 3a.

[0050] In the embodiment above, the characters or scripts 3a and the magnetic code layer 5 are alternately arranged, but it is conceivable that the characters or scripts 3a and the magnetic code layer 3, respectively, are arranged any way.

[0051] The magnetic code layer 5 according to the above embodiment implements the signal sequence by modulating the thicknesses of the magnetic code layer.

[0052] The preferred embodiment as described within this specification is to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.

Claims

1. A security device, preferably a security thread (1) for being incorporated into a document such as a banknote, comprising
 - a substrate (2) preferably of a transparent polyester layer;
 - a printed ink layer (3) arranged over the substrate (2) and having negative characters or scripts (3a) incorporated therein;
 - a magnetic code layer (5) arranged over the printed ink layer (3) and adjacent to the negative characters or scripts (3a), wherein the magnetic code layer (5) comprises a specific signal sequence;
 - characterised in that**
 - the signal sequence is formed by modulating the thickness of the magnetic code layer (5), and
 - a surface of a support layer (4) arranged between the printed ink layer (3) and the magnetic code layer (5) has, on the side of the magnetic code layer (5), different embossed recesses in accordance with the specific signal sequence resulting in different thicknesses of the magnetic code layer (5).
2. A security device according to claim 1, further **characterised by**
 - a cover layer (6) arranged on the magnetic code layer (5).
3. A security device according to claim 2, further **characterised by**
 - a heat-bondable glue or coating layer (7) on the side of the substrate (2) opposite to the magnetic code layer (5) and/or on the side of the cover layer (6) opposite to the magnetic code layer (5).
4. A security device according to any of the preceding claims, **characterised in that**

the printed ink layer (3), the support layer (4) and/or the cover layer (6) are made of a grey colour nitroacryl-soluble, resin based ink containing less than 5 % of aluminium powder.

5. A security device according to any of the preceding claims,
characterised in that
the magnetic code layer (5) is a printed layer of a magnetic ink.
6. A method of manufacturing a security device, preferably a security thread (1) for being incorporated into a document such as a banknote, comprising the steps of
providing a substrate (2) preferably of a transparent polyester layer;
arranging over the substrate (2) a printed ink layer (3) having negative characters or scripts (3a) incorporated therein; and
arranging over the printed ink layer (3) a magnetic code layer (5) adjacent to the negative characters or scripts (3a),
characterised by
the steps of
printing a support layer (4) on the printed ink layer(3);
embossing different recesses into a surface of the support layer (4), which is arranged between the printed ink layer (3) and the magnetic code layer (5), on the side of the magnetic code layer (5) in accordance with a specific signal sequence resulting in different thicknesses of the magnetic code layer (5), preferably by means of roll embossing.
7. A Method according to claim 6, further
characterised in that
in the step of arranging the magnetic code layer (5), the magnetic code layer (5) is printed on the embossed surface of the support layer (4) by means of a magnetic ink.
8. A Method according to any of claim 6 or 7, further
characterised by
the step of printing a cover layer (6) on the magnetic code layer (5).
9. A Method according to claim 8, further
characterised by
the step of arranging a heat-bondable glue or coating layer (7) on the side of the substrate (2) opposite to the magnetic code layer (5) and/or on the side of the cover layer (6) opposite to the magnetic code layer (4).
10. A Method according to any of claims 6 to 9,
characterised in that
the printed ink layer (3), the support layer (4) and/or the cover layer (6) are printed by means of a grey

colour ink, preferably nitroacryl-soluble, resin based ink containing less than 5 % of aluminium powder.

11. A Method according to any of claims 6 to 10,
characterised in that
the step of printing the printed ink layer (3) uses the corona phenomenon.

10 Patentansprüche

1. Sicherheitsvorrichtung, vorzugsweise ein Sicherheitsfaden (1), der in ein Dokument wie z.B. eine Banknote einzufügen ist, mit
einem Substrat (2), vorzugsweise aus einer transparenten Polyesterlage;
einer gedruckten Tintenlage (3), die über dem Substrat (2) angeordnet ist und negative Symbole oder Zeichen (3a) aufweist, die darin enthalten sind;
einer Magnetcodelage (5), die über der ersten Lage und angrenzend an den negativen Symbolen oder Zeichen (3a) angeordnet ist, wobei die Magnetcodelage (5) eine spezifische Signalsequenz aufweist
dadurch gekennzeichnet, dass
die Signalsequenz durch Modulieren der Dicke der Magnetcodelage (5) ausgebildet ist, und
eine Fläche einer Stützlage (4), die zwischen der gedruckten Tintenlage (3) und der Magnetcodelage (5) angeordnet ist, an der Seite der Magnetcodelage (5) verschiedene geprägte Aussparungen gemäß der spezifischen Signalsequenz aufweist, die verschiedene Dicken der Magnetcodelage (5) ergeben.
2. Sicherheitsvorrichtung gemäß Anspruch 1, des Weiteren
gekennzeichnet durch
eine Abdeckungslage (6), die über der Magnetcodelage (5) angeordnet ist.
3. Sicherheitsvorrichtung gemäß Anspruch 2, des Weiteren
gekennzeichnet durch
eine heißfügbare Klebe- oder Beschichtungslage (7) an der Seite des Substrates (2) entgegengesetzt zu der Magnetcodelage (5) und/oder an der Seite der Abdeckungslage (6) entgegengesetzt zu der Magnetcodelage (4).
4. Sicherheitsvorrichtung gemäß einem der vorherigen Ansprüche,
dadurch gekennzeichnet, dass
die gedruckte Tintenlage (3), die Stützlage (4) und/oder die Abdeckungslage (6) aus einer grauen nitroacryllöslichen Farbtinte auf Kunstharzbasis besteht, die weniger als 5% Aluminiumpulver besteht, die weniger als 5% Aluminiumpulver enthält.

5. Sicherheitsvorrichtung gemäß einem der vorherigen Ansprüche,
dadurch gekennzeichnet, dass
die Magnetcodelage (5) eine gedruckte Lage einer magnetischen Tinte ist.

6. Verfahren zum Herstellen einer Sicherheitsvorrichtung, vorzugsweise eines Sicherheitsfadens (1), der in ein Dokument wie z.B. eine Banknote einzufügen ist, mit folgenden Schritten:

Vorsehen eines Substrates (2) vorzugsweise aus einer transparenten Polyesterlage;
Anordnen einer gedruckten Tintenlage (3) mit negativen Symbolen oder Zeichen (3a), die darin enthalten sind, über dem Substrat (2); und
Anordnen einer Magnetcodelage (5) angrenzend an die negativen Symbole oder Zeichen (3a) über der gedruckten Tintenlage (3),

gekennzeichnet durch

die folgenden Schritte

Drucken einer Stützlage (4) an der gedruckten Tintenlage (3);

Prägen von verschiedenen Aussparungen in eine Fläche der zwischen der gedruckten Tintenlage (3) und der Magnetcodelage (5) angeordneten Stützlage (4) an der Seite der Magnetcodelage (5) gemäß einer spezifischen Signalsequenz, die verschiedene Dicken der Magnetcodelage (5) ergibt, und zwar vorzugsweise mittels eines Walzenprägens.

7. Verfahren gemäß Anspruch 6, des Weiteren
gekennzeichnet dadurch, dass
bei dem Schritt zum Anordnen der Magnetcodelage (5) die Magnetcodelage (5) an der geprägten Fläche der Stützlage (4) mittels einer magnetischen Tinte gedruckt wird.

8. Verfahren gemäß Anspruch 6 oder 7, des Weiteren
gekennzeichnet durch
den Schritt zum Drucken einer Abdeckungslage (6) an der Magnetcodelage (5).

9. Verfahren gemäß Anspruch 8, des Weiteren
gekennzeichnet durch
den Schritt zum Anordnen einer heißfügbaren Klebe- oder Beschichtungslage (7) an der Seite des Substrates (2) entgegengesetzt zu der Magnetcodelage (5) und/oder an der Seite der Abdeckungslage (6) entgegengesetzt zu der Magnetcodelage (4) .

10. Verfahren gemäß einem der Ansprüche 6 bis 9,
dadurch gekennzeichnet, dass
die gedruckte Tintenlage (3), die Stützlage (4) und/oder die Abdeckungslage (6) mittels einer grauen Farbtinte gedruckt sind, vorzugsweise eine nitro-

acryllösliche Tinte auf Kunstharzbasis, die weniger als 5% Aluminiumpulver aufweist.

11. Verfahren gemäß einem der Ansprüche 6 bis 10,
dadurch gekennzeichnet, dass
der Schritt zum Drucken der gedruckten Tintenlage (3) ein Corona-Phänomen ausnutzt.

10 **Revendications**

1. Dispositif de sécurité, de préférence, un fil de sécurité (1) destiné à être incorporé dans un document tel qu'un billet de banque, comprenant un substrat (2) consistant de préférence en une couche de polyester transparent ;
une couche d'encre imprimée (3) disposée sur le substrat (2) et dans laquelle des caractères d'écriture ou des caractères négatifs (3a) sont incorporés ;
une couche de code magnétique (5) disposée sur la couche d'encre imprimée (3) et adjacente aux caractères d'écriture ou caractères négatifs (3a), dans lequel
la couche de code magnétique (5) comprend une séquence de signal spécifique ;

caractérisé en ce que

la séquence de signal est formée en modulant l'épaisseur de la couche de code magnétique (5), et une surface d'une couche de support (4) disposée entre la couche d'encre imprimée (3) et la couche de code magnétique (5) comporte, du côté de la couche de code magnétique (5), différents évidements gaufrés conformément à la séquence de signal spécifique résultant en différentes épaisseurs de la couche de code magnétique (5).

2. Dispositif de sécurité selon la revendication 1, **caractérisé en outre par** une couche de couverture (6) disposée sur la couche de code magnétique (5).

3. Dispositif de sécurité selon la revendication 2, **caractérisé en outre par** une couche de dépôt ou de colle adhérent par chauffage (7) du côté du substrat (2) opposé à la couche de code magnétique (5) et/ou du côté de la couche de couverture (6) opposé à la couche de code magnétique (5).

4. Dispositif de sécurité selon l'une quelconque des revendications précédentes,
caractérisé en ce que
la couche d'encre imprimée (3), la couche de support (4) et/ou la couche de couverture (6) sont constituées d'une encre à base de résine nitroacrylique soluble de couleur grise contenant moins de 5 % de poudre d'aluminium.

5. Dispositif de sécurité selon l'une quelconque des revendications précédentes,

caractérisé en ce que

la couche de code magnétique (5) est une couche imprimée d'une encre magnétique.

l'étape d'impression de la couche d'encre imprimée (3) utilise le phénomène corona.

6. Procédé de fabrication d'un dispositif de sécurité, de préférence un fil de sécurité (1) destiné à être incorporé dans un document tel qu'un billet de banque, comprenant les étapes consistant à fournir un substrat (2) consistant de préférence en une couche de polyester transparent ; disposer sur le substrat (2) une couche d'encre imprimée (3) dans laquelle des caractères d'écriture ou des caractères négatifs (3a) sont incorporés ; et disposer sur la couche d'encre imprimée (3) une couche de code magnétique (5) adjacente aux caractères d'écriture ou caractères négatifs (3a),
caractérisé par
 les étapes consistant à imprimer une couche de support (4) sur la couche d'encre imprimée (3) ; gaufrer différents évidements dans une surface de la couche de support (4), qui est disposée entre la couche d'encre imprimée (3) et la couche de code magnétique (5), du côté de la couche de code magnétique (5) conformément à une séquence de signal spécifique résultant en différentes épaisseurs de la couche de code magnétique (5), de préférence à l'aide d'un rouleau de gaufrage.
7. Procédé selon la revendication 6, **caractérisé en outre en ce que** à l'étape de disposition de la couche de code magnétique (5), la couche de code magnétique (5) est imprimée sur la surface gaufrée de la couche de support (4) à l'aide d'une encre magnétique.
8. Procédé selon l'une quelconque des revendications 6 et 7, **caractérisé en outre par** l'étape d'impression d'une couche de couverture (6) sur la couche de code magnétique (5).
9. Procédé selon la revendication 8, **caractérisé en outre par** l'étape consistant à disposer une couche de dépôt ou de colle adhérent par chauffage (7) du côté du substrat (2) opposé à la couche de code magnétique (5) et/ou du côté de la couche de couverture (6) opposé à la couche de code magnétique (4).
10. Procédé selon l'une quelconque des revendications 6 à 9, **caractérisé en ce que** la couche d'encre imprimée (3), la couche de support (4) et/ou la couche de couverture (6) sont imprimées à l'aide d'une encre de couleur grise, de préférence une encre à base de résine nitroacrylique soluble contenant moins de 5 % de poudre d'aluminium.
11. Procédé selon l'une quelconque des revendications 6 à 10, **caractérisé en ce que**

Fig. 1

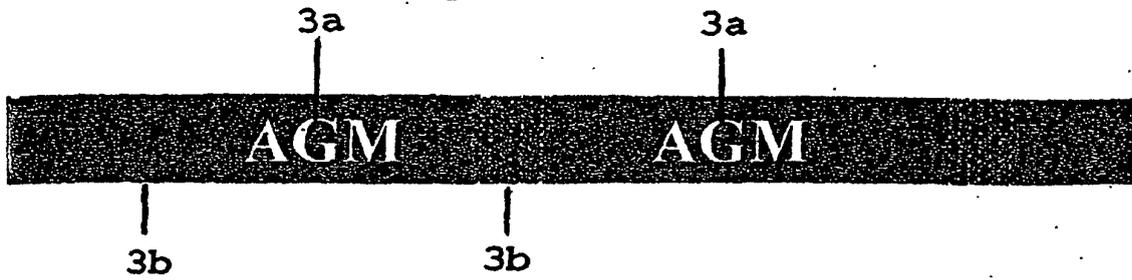


Fig. 2

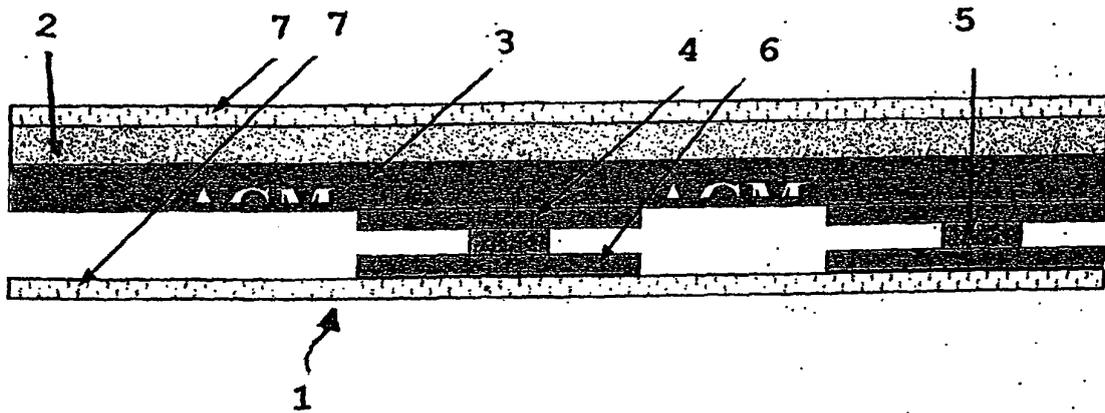
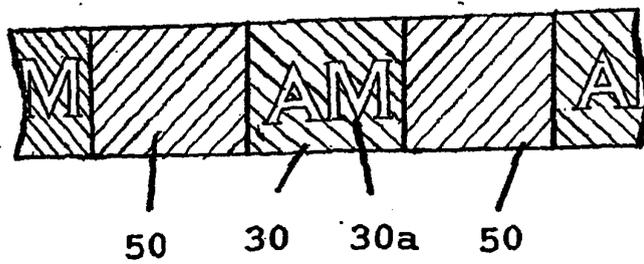


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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