

Two-dimensional identification pattern, article including such a pattern and methods for marking and identifying such a pattern

The invention relates to two-dimensional identifying patterns, particularly patterns used for identifying articles.

5 The invention also relates to the articles comprising such patterns and to methods of marking and identifying these patterns on such articles.

10 At the present time, an article is identified by a mark or a logo inscribed on the packaging of the article or on the article itself. These inscriptions are visible and allow the article to be identified by all users.

It is also possible to use other visible identifiers that contain enciphered information so that the content of the identifier is not recognized by all users.

15 For example, one-dimensional identifiers of the barcode type or two-dimensional identifiers of the data matrix type, which are most widely used, may be mentioned.

20 Barcodes represent information using a pattern consisting of bars of different thicknesses and spaces. However, these patterns are easily decipherable.

25 Moreover, data matrix identifiers use black and white pixels forming a symbol, these being arranged within a pattern having a rectangular or quadrilateral shape. The pattern of such a data matrix is made up of two L-shaped adjacent solid borders, the combination of which is called a "locating pattern" and two borders formed by alternating black and white pixels, called "reference borders". The locating pattern is used to locate and orient the symbol and the reference borders enable the number of rows and columns in the symbol to be counted. Furthermore, the data matrix also uses a
30 detection zone, sometimes called a "quiet zone", to detect the locating pattern. This detection zone is used for clearly isolating the locating pattern from any other element of the article with which it might be confused.

However, these identifiers, visible by the user, especially via their locating pattern and their detection zone, must be marked at a chosen point on the article so as not to change the nature of its general appearance. Moreover, the locating pattern is a known pattern, which
5 is the same whatever the article to be identified. This locating pattern contains no information – it serves merely to detect the symbol.

Furthermore, these data matrices, albeit provided with error correction mechanisms, are not robust enough as they depend on the substrate on which they are deposited. This is because, depending on
10 the roughness of the substrate, the latter may degrade the pattern while it is being marked on the article. The robustness of such a pattern also depends on the printing quality, since a printing defect, for example an ink that spreads, or the printing of a pixel of the symbol being absent, may greatly impair the pattern. In certain cases, a pattern in the form
15 of a data matrix measuring 16 pixels by 16 pixels may thus be made illegible by more than six pixels being destroyed.

The present invention provides a two-dimensional identifying pattern that improves the robustness of the identification of conventional articles.

20 It also provides an identifying pattern which is invisible to the user, while still being detectable by a suitable detection system.

It also provides an article comprising such an identifying pattern and methods for the marking and identification of the identifying pattern.

25 According to one aspect of the invention, what is provided is a two-dimensional identifying pattern comprising an arrangement of representations of symbols belonging to an alphabet comprising a plurality of symbols, each symbol of the alphabet comprising at least three states, including at least two valid states and at least one invalid
30 state, each representation of a symbol in said arrangement corresponding to a valid state of said symbol.

Thus, a particularly robust identifying pattern is provided since it comprises several symbols and offers a large number of possible ways of organizing a defined reference pattern. A reference pattern is

understood to mean an arrangement of symbols, and an identifying pattern is understood to mean one possible representation from among all the representations of the symbols of the reference pattern.

Furthermore, each symbol of the reference pattern may have several possible representations, thereby increasing the number of combinations of representations of a given reference pattern. Specifically, a reference pattern having a defined arrangement of symbols may have several possible representations corresponding to the possible valid states of each symbol.

Thus, the reference pattern is made illegible for a user who does not know beforehand the alphabet used to generate the reference pattern, that is to say one who does not know the valid and invalid states of the symbols. Even if a user were able to detect the states inscribed on an article, since he does not know the alphabet it would be very difficult, or even practically impossible, for him to determine the symbols from a reconstruction of all the combinations of valid and invalid states in order to recover the symbol alphabet. The fact of not being able to determine the symbols inscribed on the article makes it impossible to recover the reference pattern. In particular, the invalid state or states of the symbols make it practically impossible to read the pattern without knowing the alphabet.

In particular, if the reference pattern comprises different symbols, the number of combinations increases and makes its recognition even more difficult.

Furthermore, the identifying pattern does not require the use of a particular locator when subsequently identifying it. Compared with a pattern in the form of a data matrix, the identifying pattern according to the invention requires no specific detection zone for locating the reference pattern.

According to one embodiment, each valid state comprises at least two elements having a first possible representation and a second possible representation different from the first representation.

According to one advantageous embodiment, each state of the alphabet symbols comprises a group of elements, each of said groups

of elements comprising at least two elements. Each element comprises one possible representation from among a set of representations comprising a first representation and a second representation different from the first representation.

5 Furthermore, each symbol comprises a first valid state comprising a first group of at least one element represented according to the first representation and of at least one element represented according to the second representation, and a second valid state
10 comprising a second group of at least one element represented according to the second representation and of at least one element represented according to the first representation.

 Thus, the invention provides an identifying pattern, the symbols of which have two complementary valid states, since the first
15 element of a group for one valid state is different from the first element of the group corresponding to the other valid state. Likewise, the second element of one group is different from the second element of the other group, each group corresponding to a valid state. Valid
20 states that have differently arranged representations are therefore provided. For example, when the same ink area is used to represent these complementary valid states on the article, the identifying pattern is made homogeneous on a macroscopic scale, making it more difficult
25 to detect. This is because, if each element is for example produced by an ink dot or spot of defined area, the fact that the valid states all have the same number of ink dots or spots makes it possible to obtain the same ink area and therefore the same surface density of ink for all the
30 valid states and therefore also for the identifying pattern formed by the arrangement of the various symbols in one or other of their valid states.

 According to another embodiment, each of said groups of
30 elements comprises more than two elements. Each symbol comprises a first valid state comprising a first group of several elements represented according to a first representation and of several elements represented according to a second representation. Each symbol also comprises a second valid state comprising a second group of several

elements represented according to the second representation and of several elements represented according to the first representation. For example, there may be four elements in each group, without this number being limiting.

5 Thus, the invention provides an identifying pattern comprising complex symbols. This increases the difficulty of recognizing the reference pattern when subsequently an unauthorized identification is attempted.

10 The aforementioned groups of elements may preferably comprise the same number of elements, thereby improving the homogeneity of the identifying pattern in order to make it even more difficult to detect when said elements are formed by an ink dot or spot of defined area.

15 According to a preferred embodiment, at least one valid state of at least one symbol of said identifying pattern represents an item of digital information. Thus, an item of digital information may be enciphered using the valid states of the symbols of the identifying pattern.

20 Thus, the invention provides a very robust enciphering means, since it is firstly necessary to recognize the identifying pattern and then identify its content before accessing the information that it contains.

25 The valid states of each symbol of the reference pattern may represent respectively binary values of an item of digital information. The reference pattern is therefore particularly suitable for enciphering binary information.

 According to another aspect of the invention, there is provided an article comprising at least one identifying pattern defined above.

30 This article may be any type of medium for the identifying pattern, such as a can, a foil, for example aluminum foil, a capsule or a cartridge possibly containing, for example, a comestible substance, such as coffee or an infusion, a bottle stopper, a banknote, a passport, a security document, a label, a card, a voucher, a pharmaceutical pill, a watch, or any medium having a metallic or ceramic surface, a

package, a semiconductor, a computer peripheral (mouse, keyboard, etc.), etc.

According to one embodiment, at least one identifying pattern is present on the article, for example on a layer of said article.

5 The article may comprise several identifying patterns corresponding to one or more representations of the same reference pattern.

10 By repeating the identifying pattern, its subsequent identification is made more robust. This repetition prevents any degradation in detecting the reference pattern, since any degradation of an identifying pattern does not prevent the presence of at least one reference pattern being detected from among the set of identifying patterns marked on the article.

15 The identifying patterns may be all the same or all different in their representation.

20 The article may furthermore comprise identical identifying patterns and different identifying patterns in the way they are represented, that is to say the valid states of which, used for representing the various symbols, are not the same for all the symbols of the reference pattern used.

According to another aspect, the invention also provides a method for the marking of an article with an identifying pattern that may contain an item of information relating to the article and/or its use. The method comprises the following steps:

- 25 - an alphabet consisting of several symbols is defined;
 - for each symbol, at least two valid states and at least one invalid state are defined;
 - a reference pattern comprising a set of symbols of the aforementioned alphabet is generated;
 30 - at least one representation of said reference pattern is generated by assigning a specific valid state to each symbol of the reference pattern; and finally
 - a marking reproducing said representation of the reference pattern is applied to the article.

Thanks to the structure of the identifying pattern used, the roughness of the medium or the printing quality cannot degrade the pattern since several symbols of the identifying pattern may be distorted without in any way preventing it from being subsequently identified.

Each symbol may be represented by at least two elements having a first possible representation and a second possible representation.

Preferably, each valid state comprises a group of at least one element represented according to the first representation and of at least one element represented according to the second representation, each valid state of one symbol being different from a valid state of another.

According to another embodiment, each invalid state of a symbol is different from the valid states of any one of the symbols of the alphabet.

The valid states of all the symbols may be represented by a group of elements comprising the same number of elements.

In another aspect, the invention also provides a method for the identification of an identifying pattern applied on an article and possibly containing an item of information relating to the article and/or its use. This method comprises the following steps:

- an image of an area of the article, on which at least part of a representation of at least one stored reference pattern appears, is captured, said pattern comprising an arrangement of several symbols belonging to a stored alphabet, each symbol comprising at least two valid states and at least one invalid state and each representation of a symbol in said arrangement corresponding to a valid state of said symbol, and the captured image is stored;

- the symbols of the stored symbol alphabet are identified by comparing the captured image with the arrangement of representations of symbols of the stored reference pattern;

- the number of identified symbols, represented in a valid state and arranged according to the arrangement of said stored reference pattern, is calculated;

- the result of the calculation is compared with a probability threshold; and

- an identification signal is transmitted if the result reaches said threshold.

According to yet another embodiment, a first symbol in a first position of the arrangement of the stored reference pattern is defined; a representation of at least one valid state of said first symbol is sought in the captured image; if this representation is found, it is considered that the selected symbol is identified; another symbol in another position of the arrangement of the stored reference pattern is then defined; and the previous searching step is repeated for this other symbol in this other position, and so on until all the symbols of the stored reference pattern have been identified or not.

In another embodiment, the method includes a step of deciphering at least one item of digital information represented by at least one valid state of at least one symbol of the identifying pattern, which comprises identifying said item of digital information from at least one valid state of at least one identified symbol.

In all cases, the identification method is particularly robust because it requires both the recognition of the states of a plurality of stored symbols and the recognition of a specific arrangement of a certain number of these symbols in a valid state, this arrangement constituting a stored reference pattern.

Other advantages and features of the invention will become apparent on examining the detailed description of a few entirely nonlimiting implementational and embodiment examples, and the appended drawings in which:

- figure 1 illustrates schematically one way of implementing a step in the formation of an identifying pattern according to the invention;

- figure 2 illustrates schematically one way of implementing a step in the formation of another identifying pattern;

5 - figure 3 illustrates schematically one way of implementing a method for the marking of the identifying pattern of figure 1 on an article; and

- figure 4 illustrates schematically one way of implementing a method for the identification of an identifying pattern applied on an article.

10 In the figures, the same references correspond to the same elements. In the figures, the elements have not necessarily been drawn to scale.

Figure 1 shows schematically one way of implementing a step S1 in the formation of a two-dimensional reference pattern P1 according to the invention.

15 This reference pattern P1 comprises an arrangement of four defined symbols A, B, C and D from an alphabet AT1.

A two-dimensional reference pattern is intended here to mean an arrangement of several two-dimensional symbols that are arranged in a defined position one with respect to another.

20 An arrangement of symbols is understood to mean a particular arrangement of the two-dimensional symbols in the reference pattern.

An identifying pattern is understood to mean one possible representation from among all the representations of the symbols of the reference pattern.

25 A symbol is understood here to mean a two-dimensional combination of elements. An element of a symbol may for example be a dot or a combination of dots, such as an alphabet letter or an asperity, such as an indentation, a hole or a protrusion. An element may for example also be a color or a reflection of electromagnetic waves.

30 The set of these symbols forms what is called here an alphabet. In this alphabet, the symbols differ from one another even if the symbols may comprise elements of the same type, as described above.

According to the invention, each symbol of the alphabet comprises several states, in particular more than two states, that is to say at least three states.

5 A state is one possible representation of a symbol. For example, if a symbol is a letter, one possible representation of a state is a letter in lower case, another state or other possible representation is the same letter in upper case, yet another state or different representation is the same letter colored red, etc.

10 If the symbol is a word, a representation of a state may be a word written from left to right, or vice versa. If the symbol is a combination of dots, one possible representation of a state may be a single dot or a pair of dots, another representation may be a non-dot, in other words the absence of a dot, or a pair of non-dots, etc.

15 A valid state of a symbol is a state arbitrarily chosen or permitted from among all the possible states of this symbol. In other words, a valid state is a unique representation from among all the possible representations of the states of the symbol.

20 An invalid state is, *a fortiori*, a non-permitted state, that is to say another representation, different from that used for the valid states of the same symbol. It should be noted that an invalid state of a symbol, for a defined alphabet, may be identical to a valid state of another symbol of the defined alphabet.

25 Figure 1 shows an example of an alphabet AT1 comprising four symbols A, B, C and D. Each symbol A, B, C and D comprises two valid states Vi1 and Vi2 and two invalid states Ii1 and Ii2. Each state of all the symbols comprises two groups of elements G1 to G16. In this embodiment, each group G1 to G16 comprises two elements. Each element comprises a first representation E1 corresponding to a dot, that is to say a solid circle, and a second representation E2
30 corresponding to a non-dot, i.e. an empty circle or the absence of a dot.

As may be seen in figure 1, the symbol A of the alphabet AT1 has a first valid state Vi1 for which the group G1, placed vertically, is formed by a dot E1 at the top and a non-dot E2 at the bottom.

The symbol A has a second valid state Vi2 for which the group G2, again placed vertically, is formed by a non-dot E2 at the top and a dot E1 at the bottom. The two valid states Vi1 and Vi2 may for example represent the respective values 0 and 1 so as to provide binary information encoding.

The same symbol A has two invalid states Ii1 and Ii2 comprising two groups G3 and G4 of two elements, each placed vertically. In the first invalid state Ii1, the group G3 is formed by two non-dots E2 one above the other, whereas, in the second invalid state Ii2, the group G4 is formed by two dots E1 located one above the other, but being however separated by a gap.

The symbol B has a valid state Vi1 for which the group G5, placed horizontally, is formed by a dot E1 on the left-hand side in figure 1 and a non-dot E2 on the right-hand side in figure 1. The symbol B has a second valid state Vi2 for which the group G6, again placed horizontally, is formed by a non-dot E2 placed on the left in figure 1 and a dot E1 placed on the right in figure 1. The same symbol B has two invalid states Ii1 and Ii2 comprising two groups of two elements G7 and G8 placed horizontally. In the first invalid state Ii1, the group G7 is formed by two non-dots E2 placed horizontally side by side, whereas in the second invalid state Ii2, the group G8 is formed by two dots E1 placed side by side, but being however separated by a central gap.

The symbol C has a valid state Vi1 for which a group G9, placed diagonally in a first direction in figure 1, is formed by a dot E1 placed at the top left in figure 1 and a non-dot E2 placed at the bottom right. The second valid state Vi2 of the symbol C has a group G10, again placed diagonally in the same direction as the group G9, formed by a non-dot E2 located at the top left in figure 1 and a dot E1 located at the bottom right in figure 1. The same symbol C has two invalid states Ii1 and Ii2 comprising two groups of two elements G11 and G12 oriented diagonally in the same direction as the groups G9 and G10 of the two valid states Vi1 and Vi2 of the same symbol C. The groups

G11 and G12 are formed respectively by two non-dots E2 and two dots E1 placed at the ends of the diagonal and separated by a central gap.

5 The symbol D has two valid states Vi1 and Vi2 formed by the groups G13 and G14, placed diagonally in the opposite direction to the direction of the groups G9 to G12. The group G13 corresponding to the first valid state Vi1 of the symbol D is formed by a dot E1 placed at the top right and a non-dot E2 placed at the bottom left in figure 1. The group G14 corresponding to the second valid state Vi2 of the symbol D is formed by a non-dot E2 placed at the top right and a dot E1 placed at the bottom left in figure 1.

10 The two invalid states Ii1 and Ii2 of the symbol D correspond to the two groups G15 and G16 each comprising two elements oriented diagonally in the same direction as the groups G13 and G14. The group G15 is formed by two non-dots E2, whereas the group G16 is formed by two dots E1 placed at the ends of the diagonal and separated by a central gap.

20 During the formation step S1, a reference pattern P1 is constructed from the symbols A, B, C and D belonging to the alphabet AT1. In this embodiment, the pattern P1 comprises thirty-two symbols in a specifically determined particular arrangement, for example determined in a manner depending on the information that the reference pattern has to convey. Figure 1 shows that the reference pattern P1 is constructed from vertical, horizontal and diagonal arrangements of the various groups G1 to G16. The thirty-two symbols A, B, C and D form a mutually imbricated arrangement as illustrated in figure 1.

25 As shown especially in figure 1, the imbrication of the various symbols is preferably such that the various dots and non-dots are, in this example, aligned vertically and horizontally. To give an example, it should be noted that, along the upper, first horizontal line x-x illustrated in figure 1 of the reference pattern P1, there are, in succession starting from the left and going to the right, one element of the symbol A, the group of elements of which is placed vertically, two elements of the symbol B that are placed horizontally, one element of

the symbol D placed diagonally in the second aforementioned direction, two elements of the symbol B placed horizontally, and two elements of the symbol B again placed horizontally. The second horizontal line of the reference pattern P1, denoted by y-y in figure 1, comprises the second element of the symbol A, the first element of which was on the first line x-x, and, again going from left to right, an element of the symbol C placed diagonally in the first aforementioned direction, the second element of the symbol D placed diagonally, the first element of which formed part of the first line x-x, followed by the elements of the two symbols C, two elements of the symbol B and one element of the symbol D.

Likewise, the first vertical line denoted by z-z of the symbol or reference pattern P1 illustrated in figure 1 is formed, going from the top downward, by two elements of the symbol A placed vertically, one element of the symbol B placed horizontally, one element of the symbol C placed diagonally in the first direction, two elements of the symbol A placed vertically, one element of the symbol D placed diagonally in the second direction and one element of the symbol B placed horizontally.

Of course, it will be understood that a different arrangement could be adopted. However, it is advantageous for the various symbols to be suitably imbricated so as to make detection more difficult for a person unaware of the construction of the reference pattern and the alphabet used.

It will also be noted that, in the example illustrated, each of the symbols A, B, C and D has two valid states Vi1 and Vi2 in which the various groups of two elements comprise each time one dot and one non-dot. In contrast, the invalid states Ii1 and Ii2 of the four symbols A, B, C and D each time are formed by a group of two elements of the same nature, i.e. two dots or two non-dots. This particular structure further increases the robustness of the reference pattern that it is possible to produce by the formation operation S1.

There are then several possible ways such as P1', P1'', etc. for representing the reference pattern P1 thus produced. These

representations $P1'$, $P1''$ of the reference pattern $P1$ are also denoted hereafter by identifying patterns. Specifically, taking into account the fact that each symbol A, B, C and D may be represented by two separate valid states $Vi1$, $Vi2$ and that the pattern $P1$ comprises thirty-

5 two symbols, there are $2^{32} = 4\,294\,967\,296$ possible ways of representing the defined reference pattern $P1$. In another example, if the pattern comprises sixty-four symbols there are then $2^{64} = 18446744073709551616$ possible ways of representing the defined reference pattern $P1$. Thus, each representation of a reference pattern

10 such as $P1$ may correspond to an item of information, making it possible for an article to which one possible representation of the reference pattern has been affixed to be characterized. For example, it is possible to characterize the manufacturing origin of the article, its distribution site, etc. All this information serves to identify an article

15 in a unique manner and thus helps to combat any infringement if said article is for example distributed by an unentitled person. As a variant, the information item is exclusively referenced in the specific arrangement of the reference pattern $P1$, the formation of the various representations $P1'$, $P1''$, etc., this taking place randomly so as to

20 make the information contained in the reference pattern $P1$ completely undetectable.

Figure 1 illustrates two possible representations $P1'$ and $P1''$ of the reference pattern $P1$ that are obtained by the operation $S2$. For each possible representation $P1'$, $P1''$, the elements $E1$, $E2$ of the valid

25 states $Vi1$, $Vi2$ of the symbols A, B, C and D of the reference pattern $P1$ are shown. For example, in the representation $P1'$, it should be noted that the symbol $A1$ is represented by its valid state $Vi1$ as illustrated in figure 1, i.e. with a dot $E1$ at the top and a non-dot $E2$ at the bottom. It should also be noted in the first horizontal line of the

30 identifying pattern $P1'$ that the symbol $B1$ is in its valid state $Vi1$, i.e. with a dot $E1$ on the left in figure 1 and a non-dot $E2$ on the right of the figure. It should also be noted, again in the identifying pattern $P1'$, the symbol $C1$ is in its first valid state $Vi1$, i.e. with a dot $E1$ at the top left and a non-dot $E2$ at the bottom right, these two elements being

placed diagonally along the first aforementioned direction. It should also be noted in the representation P1' that the symbols A2, B2 and C2 use the second valid state Vi2 and the symbols D1, D2 use the valid states Vi1 and Vi2 respectively.

5 In the representation P1'', it may be noted that the symbol A1 indicated previously in the representation P1' is identical, whereas the symbol B1 is replaced with B2, represented in its second valid state Vi2, namely with a non-dot E2 on the left and a dot E1 on the right. In other words, this symbol B in this position of the reference pattern P1
10 is used here with its representation corresponding to a valid state other than in the representation P1'. Likewise, the symbol C mentioned previously, and denoted by C1 in figure 1 in the case of the representation P1', is used, in the case of the representation P1'', in its second valid state Vi2, namely with a non-dot E2 at the top left and a
15 dot E1 at the bottom right and denoted by C2.

Examining the two representations P1' and P1'' illustrated in figure 1 shows that a number of symbols A, B, C and D are thus used either in a first valid state Vi1 or in a second valid state Vi2, so that the two representations P1' and P1'' are completely different although
20 the same reference pattern P1 has been used.

Figure 2 shows schematically another way of implementing a step S1 in the formation of a reference pattern P2.

Figure 2 shows an alphabet AT2 that comprises three symbols A', B' and C'. Each symbol A', B' and C' has two valid states Vi1 and Vi2 and fourteen invalid states I1 to I14. As in the previous example,
25 the two valid states Vi1 and Vi2 may represent the values 0 and 1 respectively for the binary encoding of an item of information contained in an identifying pattern. Each state of all the symbols comprises a group of elements such as G1 and G2 in the case of the two valid states Vi1 and Vi2, or GI1, GI2, GI3, ...GI13, GI14 in the
30 case of the invalid states I1 to I14. Each group of elements G1 to GI14 comprises four elements each having a first representation E1 corresponding to a dot, i.e. a solid circle, and a second representation E2 corresponding to a non-dot, i.e. an empty circle or the absence of a

dot. In the example illustrated in figure 2, the two groups G1 and G2 corresponding to the two valid states Vi1 and Vi2 each time have two representations E1, i.e. two solid dots, and two representations E2, i.e. two non-dots. The advantage of such a choice is that an identifying pattern P2' or P2'', obtained as will be explained below, is homogeneous, i.e. each group G1, G2 corresponding to the two valid states has the same density of dots E1. If these elements or dots E1 are produced by printing with an ink, the result is that the surface density of the ink on the pattern remains constant.

As may be seen in figure 2, each group of two elements for the various symbols A', B' and C' is approximately in the form of a square, at the four corners of which the dots E1 and the non-dots E2 are placed. Thus, in the case of the symbol A' in the valid state Vi1, two dots E1 are aligned vertically in the left-hand part of this square, in relation to figure 1, and two non-dots E2 are aligned vertically in the right-hand part of the square. For the valid state Vi2 of the same symbol A', two dots E1 are aligned vertically on the right-hand side of the square and two non-dots E2 are aligned in the left-hand part of the square.

In respect of the symbol B', two dots E1 are aligned horizontally at the top of the square for the valid state Vi1 and at the bottom of the square for the valid state Vi2. In respect of the symbol C', two dots E1 are diagonally opposed in two corners of the square along one diagonal oriented along a first direction in the valid state Vi1 and along the other diagonal, oriented in the other direction, for the valid state Vi2. The non-dots E2 are each time placed at the corners that are left free by the dots E1.

The various invalid states may comprise, for each of their groups GI1 to GI14: no dot E1, a single dot E1, two dots E1, or three dots E1, or four dots E1 as for example in the case of the group GI14. Here again, the non-dots E2 are placed at the locations left free by the dots E1.

Having thus defined this alphabet AT2, it is possible to create a reference pattern P2 during a formation step denoted by S1 in figure 2,

by placing a number of symbols A', B' and C' in a defined arrangement. In the example illustrated in figure 2, the reference pattern P2 takes the form of a square comprising sixteen symbols A', B' and C' in a specific arrangement illustrated in figure 2.

5 During a step denoted by S2, one of the two valid states, either Vi1 or Vi2, is assigned to each symbol of the reference pattern P2. This assignment is performed in a random manner or a manner specifically defined according to the item of information that the reference pattern must represent. By way of example, figure 2 shows
10 two possible representations denoted by P2' and P2''. Of course, it will be understood that a large number of other possible representations may be envisaged with the two valid states Vi1 and Vi2. The two representations P2' and P2'' differ by the use of different valid states for certain symbols of the reference pattern P2. Thus, the symbol A' located in the top left corner of the representation P2 is represented in
15 the form of the valid state Vi1 corresponding to the group G1 of the alphabet AT2. The same symbol A' in the top left corner of the representation P2'' is represented in the form of the valid state Vi2 corresponding to the group G2.

20 Figure 3 shows schematically one way of implementing a method of marking an article SUP by means of two representations P1' and P1'' of a reference pattern P1 as described and illustrated in figure 1.

25 This method comprises the step S1 of forming a reference pattern P1 comprising an arrangement of thirty-two symbols A, B, C and D, as described in relation to figure 1, a step S2 of assigning valid states to the reference pattern P1 produced and a step S3 of marking the representations obtained, P1' and P1'', of the valid states of the symbols A, B, C and D on the article SUP.

30 The term "marking" is understood to mean printing, for example with ink, engraving, i.e. production of hollows and bumps on a medium, for example a metallic medium, or any type of known representation of a pattern on an article. This marking may be visible, for example when it is produced on a visible scale, or invisible when it

is produced in the form of symbols, for example magnetic symbols, that can be detected only by appropriate measuring equipment.

Several means may be used to make the identifying pattern undetectable to the naked eye. For example, it is possible to use an ink
5 having a chemical nature that makes it invisible to the naked eye but easily visible under a specific illumination, for example using ultraviolet or infrared radiation.

Advantageously, to enhance the security of the marking with the representations of the reference pattern, it is possible to use inks
10 having a chemical nature that makes it invisible to the naked eye. The composition of this ink may comprise one or more pigments and/or dyes that absorb in the visible or invisible portion of the electromagnetic spectrum and/or may also comprise one or more pigments and/or dyes that are luminescent. Nonlimiting examples of
15 appropriate pigments and/or of dyes that absorb in the visible or invisible portion of the electromagnetic spectrum include phthalocyanine derivatives. Nonlimiting examples of appropriate luminescent pigments and/or of dyes comprise lanthanide derivatives. The presence of one or more pigments and/or dyes makes it possible to
20 improve and enhance the security of the marking so as to combat infringement.

The identifying pattern may also be mixed with a noise, for example by incorporating the identifying pattern in an environment of the surface of the article SUP, for example pre-existing irregularities.
25 These irregularities must be comparable in size to that of the pattern.

Moreover, a very small printing size, namely from 150 to 500 dpi (dots per inch, i.e. a number of pixels per inch, one inch being equivalent to 2.54 centimeters) may be used which represents the precision of the printing. On such a printing scale, the identifying
30 pattern cannot be differentiated by the naked eye from the background of the printing medium. Furthermore, to reproduce the identifying pattern would then require the use of an even finer scale to avoid any reproduction error, which in practice is virtually impossible. As illustrated in figure 3, during the step S1 of forming the reference

pattern P1, one particular arrangement of the symbols from among the symbols A, B, C and D of the alphabet AT1 is determined, as explained above. Then, during the assigning step S2, a valid state Vi1 or Vi2 is assigned to each symbol of the pattern P1 so as to obtain
 5 various possible representations P1', P1'', etc. from among all the possible representations.

Next, during the marking step S3, the one or more representations such as P1', P1'', etc. of the reference pattern P1 are marked on the article SUP by marking it with the representations E1, E2 of the valid states Vi1, Vi2 that have been assigned to each symbol
 10 of the pattern P1.

The identifying pattern P1', P1'' serves to encode an item of information about the article SUP and/or its method of use.

In the example illustrated in figure 3, two representations P1', P1'' of the reference pattern P1 are marked on the article SUP. In other
 15 words, the article SUP is marked, for each representation P1', P1'' of the reference pattern P1, with the dot/non-dot representations of each symbol A, B, C and D of the reference pattern P1. Of course, the article could be marked only with a single representation, such as P1',
 20 or else a larger number of representations of the reference pattern P1.

Moreover, the fact of producing an alphabet in which the invalid states of the symbols comprise the same representations as those used for the valid states, but in a different arrangement, makes it more difficult to recognize the identifying pattern. Specifically taking
 25 the example of the alphabet AT2, the invalid state I10 in the case of the symbol B' corresponds to the valid state Vi1 of A'. A person unaware of the reference pattern P2 could therefore read it incorrectly, believing that the symbol A' has been detected. However, by knowing the reference pattern P2 he would correctly locate the symbol A' and
 30 resolve the ambiguity.

If the user does not know the reference pattern beforehand, it is therefore practically impossible for him to be able to recognize it from among the states represented on the article SUP. In particular, there would be one chance in 4 294 967 296 of determining the reference

pattern P1 when the latter comprises thirty-two symbols as illustrated in figures 1 and 3. If the reference pattern P1 were to comprise sixty-four symbols, there would then be one chance in 2^{64} of determining the reference pattern P1.

5 The reference pattern P1 or P2 may also be used to encipher an item of digital information. The valid states Vi1, Vi2 of the symbols of the reference pattern may then be used to encode this item of digital information, which may have a binary numerical value.

10 For example, the binary value 1100 (or 12 in decimal) may be encoded with the first four symbols SP1, SP2, SP3 and SP4 illustrated in figure 3 of the defined reference pattern P1. To do this, the following code may be produced, for each symbol A, B, C and D of the defined reference pattern P1: the first valid state Vi1 corresponds to the value 1 and the second valid state Vi2 corresponds to the value 0.

15 In this case, the first symbol SP1 of the defined reference pattern P1 corresponds to the value 1, the second symbol SP2 of the defined pattern reference P1 corresponds to the value 1, the third symbol SP3 of the defined reference pattern P1 corresponds to the value 0 and the fourth symbol SP4 of the defined reference pattern P1 corresponds to the value 0. Thus, the first four symbols represent the decimal value 12. Other codes may also be chosen whereby each first valid state of the symbols of the reference pattern P1 corresponds to 1 or 0, depending on the code chosen. This item of digital information may be a production date, a product reference, for example a reference to its manufacturing site, its distribution site or its content, data

25 characteristic of the article on which the pattern is represented, etc.

30 The marking method using the reference pattern P2 illustrated in figure 2 is carried out in the same way with, during the marking step S3, the use of one or more representations P2', P2'', etc. of the reference pattern P2 on an article SUP.

 Figure 4 shows one way of implementing a method for the identification of an identifying pattern P1', P1'' affixed to or marked on the article SUP.

Stored beforehand is an alphabet and a reference pattern, i.e. a particular arrangement of a number of symbols of the stored alphabet.

In the example illustrated, the identification method comprises a step D1 in which an image of an area of the article SUP is captured,
5 a symbol identification step D2 and a step D3 for the identification of the identifying pattern P1, P1". This method may further include a step D4 of deciphering an item of digital information.

During step D1, an image ID1 of an area of the article SUP is captured using, for example, a decoding camera, the image being
10 stored in a memory. During step D2, the symbols contained in this stored image ID1 are then identified from the stored alphabet used when marking the representations P1', P1" on the article SUP.

The symbol identification step D2 applies to a captured image comprising one or more identifying patterns.

15 The arrangement of the symbols of the reference pattern, and therefore the position of each symbol in the reference pattern, is known beforehand.

The stored reference pattern is therefore superposed on an area of the captured image. A symbol of the reference pattern, for example
20 a first symbol positioned at the top left of the reference pattern, is then selected and the representation of a symbol of the alphabet contained in the area of the captured image, located in the same position as that of the selected symbol, is determined. If the determined representation corresponds to at least one representation of
25 a valid state of a first selected symbol of the reference pattern, the selected symbol in the reference pattern is considered to have been identified in the area of the image captured. If this is not the case, the selected symbol is not considered to have been identified.

Another symbol of the reference pattern, preferably a symbol
30 immediately adjacent to the previous one, is then selected and the comparison between the symbol representation of the area of the image located in the position of the second selected symbol and the representations of the valid states of the latter is reiterated. If the symbol representation of the image corresponds to at least one

representation of a valid state of the second symbol, the second symbol is considered as being identified. The preceding step is then repeated for each symbol of the reference pattern by comparing a representation of the image located at the same position as the selected
 5 symbol of the reference pattern with the representations of the valid states of the latter until all the symbols of the reference pattern have or have not been identified.

If at least one symbol is identified, the following step D3 for the identification of the identifying pattern is carried out, otherwise
 10 the camera, or the article, may for example be moved and the method repeated starting with a new captured image, i.e. by shifting, in the captured image, by an amount equal to the height or width of a symbol of the stored alphabet and repeating the method in another area of the captured image. The physical shift, for the purpose of capturing a new
 15 image, may be accomplished by moving the camera, for example stepwise, the width of a step corresponding approximately to the width or height of a representation of an element of a symbol, or by moving the article, while keeping the camera stationary. The shift in the captured image may be performed by software means with a defined
 20 pitch in terms of number of pixels and depending on the resolution of the image.

In a practical embodiment, quite a large number of identifying patterns may be provided, these being placed on the article, side by side and one above another, for example 20×20 identifying patterns.
 25 The display camera may then be stationary and contain a large number of identifying patterns to carry out the aforementioned identification.

When carrying out step D3, the number of identified symbols is calculated. If all the symbols are identified, the identifying pattern is considered to have been identified. The term "identified symbol" is
 30 understood here to mean a symbol detected in the image ID1 that corresponds to a symbol of the stored reference pattern and is also placed on the article in the arrangement of the symbols of the reference pattern.

If, on the contrary, the detected symbols in the image ID1 are not all the same as those of the stored reference pattern, then the number of identified symbols is calculated and if this number is greater than a probability threshold, the identifying pattern is considered to have been identified.

For example, in a preferred embodiment, the two-dimensional reference pattern is a 16×16 pattern, i.e. one comprising 256 states, namely 128 pairs of states. In this case, it is considered that recognition of thirty pairs of states, correctly arranged in relation to the reference pattern, suffices for considering that the identifying pattern has been recognized. In other words, considering an alphabet comprising symbols having its valid states represented by a pair of states and considering a 16×16 reference pattern comprising 128 symbols, it is sufficient to identify 30 symbols of the 128 symbols of the identifying pattern in order to consider that the identifying pattern has been identified. In this case, the probability threshold is about 24%.

According to another example, considering an alphabet comprising symbols, the valid states of which are represented by four states, and considering a 16×16 reference pattern comprising 64 symbols, it is sufficient to identify 10 symbols of the 64 symbols of the identifying pattern in order to consider that the identifying pattern has been identified. In this case, the probability threshold is about 16%.

Partial impairment of a number of symbols of an identifying pattern may therefore be tolerated, thereby confirming the robustness of the method of identifying the identifying pattern.

If the percentage of identified symbols is sufficient, the identifying pattern contained in the image is then considered to correspond to a representation of the reference pattern that was stored. This probability threshold makes it possible to tolerate errors in reading the representations contained in the image or errors in the representation of the identifying pattern when marking an article with the latter.

It will be noted that, when marking the valid states of the reference pattern on the article, invalid states seem to appear because of the alphabet used in which the symbols comprise at least one invalid state. This makes it even more difficult for an unauthorized user to determine the valid symbols and consequently this makes the identifying pattern practically undetectable.

A margin in the heightwise and widthwise shift for each dot of each symbol is tolerated. Slight diameter differences in the dots or spots that define the representations of the symbols do not impair the detection. Nor do slight position differences impair the detection, since the identifying pattern is read by comparing one position of a symbol relative to another position.

In the case in which the identifying pattern is considered not to have been recognized, that is to say if the identification conditions defined above are not valid, it is signaled that the article is not identified (see the “no” arrow in figure 4). If on the contrary the article is identified (see the “yes” arrow in figure 4), the information contained in the identifying pattern may be taken into account, for example in order to trace the manufacturer of the article or to use the article in a certain manner (permitted washing temperature, recommended vapor pressure, etc.).

According to another embodiment, the identifying pattern may represent an item of digital information and the identification method includes a step D4 in which the value of the digital information is identified from the valid states of the symbols of the recognized identifying pattern and from the code used when enciphering said digital information.

The identification method may also include steps for correcting conventional errors, so as to determine the expected valid states of the symbols that have not been able to be identified during step D2 of determining the states of the identified symbols.

Thus, using error corrections it is possible to consider that the identified symbols correspond to those of the reference pattern determined with greater reliability.

The invention also provides a system for the two-dimensional representation of a reference pattern configured for implementing the method described in figure 3.

5 In one embodiment, the representation system comprises at least one memory configured to store an alphabet, such as AT1 or AT2, comprising several symbols, means for producing a reference pattern P1 or P2 from this alphabet, and representation means configured so as to represent at least one possible representation of the reference pattern produced P1. These representation means are
10 furthermore configured for randomly assigning, to each symbol of said reference pattern produced, a valid state from among the valid states of said symbol and for storing the representations of the reference pattern P1 resulting from the assignment in a memory.

Furthermore, the system comprises marking means for marking
15 the representations of the reference pattern P1 on a medium SUP. These marking means are, for example, inkjet or laser printing means, engraving means, using the known techniques such as photogravure, intaglio printing, laser engraving, engraving using a milling cutter or engraving hollows on metal (for example using a cutting tool or acid)
20 depending on the surface used. Furthermore, the marking means may be flexography printing means, screen printing means, pad printing means (the marking method then involving ink transfer using a flexible pad), lithography means or xerography means. For example, the marking means are capable of marking the representations of the
25 reference pattern using an ink visible to the naked eye or invisible to the naked eye.

These marking means may also be thermal printing means or embossing means, which may be used, for example, on polymeric or metallic surfaces.

30 Each marking technique is used according to the type of article on which the identifying pattern or patterns are marked.

The invention also provides a system for the identification of the identifying pattern obtained according to the two-dimensional

representation method described in figure 3, configured so as to implement the identification method described in figure 4.

5 In one embodiment, the identification system comprises a detector, for example a digital camera, capable of detecting an area of the article comprising representations of symbols. The identification system also comprises at least one memory configured so as to store an alphabet and a reference pattern defined on the basis of said alphabet, determination means, for determining the symbols having a valid state among the symbols of the detected area, and comparison means, for
10 comparing all of the symbols that have a valid state and their arrangement in the detected area with the defined reference pattern stored in memory.

Furthermore, the robustness of the method of identifying the identifying pattern may be improved by having several (identical or
15 different) representations of the reference pattern on the article. Thus, it is unnecessary to place the article in a precise position when the detector is stationary.

The abovementioned means may be produced as software within a microprocessor and/or by logic circuits.

20 The identifying pattern thus defined allows articles to be identified robustly. Such an identifying pattern is also illegible to the unauthorized user and does not change the nature of the article on which it is inscribed. This identifying pattern also allows an article to be identified reliably, for better traceability of the article. In a
25 commercial context in which many infringements exist, the proposed identifying pattern allows information to be carried so as to combat any fraudulent use of articles.

CLAIMS

1. A two-dimensional identifying pattern, characterized in that it comprises an arrangement of representations (E1, E2) of symbols (A, B, C, D) belonging to an alphabet (AT1, AT2), each symbol of the alphabet comprising at least three states, including at least two valid states (Vi1, Vi2) and at least one invalid state (Ii1, Ii2), each representation of a symbol in said arrangement corresponding to a valid state of said symbol.

2. The pattern as claimed in claim 1, wherein each valid state comprises at least two elements having a first possible representation (E1) and a second possible representation (E2) different from the first representation.

3. The pattern as claimed in claim 1 or 2, wherein each state of the alphabet symbols comprises a group of elements (G1, G2), each of said groups of elements comprising at least two elements, each element having one possible representation from among a set of representations comprising a first representation (E1) and a second representation (E2) different from the first representation, and wherein each symbol comprises a first valid state comprising a first group (G1) of at least one element represented according to the first representation (E1) and of at least one element represented according to the second representation (E2), and a second valid state comprising a second group (G2) of at least one element represented according to the second representation (E2) and of at least one element represented according to the first representation (E1).

4. The pattern as claimed in claim 3, wherein each of said groups (G1, G2) of elements comprises more than two elements and wherein each symbol comprises a first valid state comprising a first group (G1) formed of several elements represented according to the first representation (E1) and of several elements represented according

to the second representation (E2), and a second valid state comprising a second group (G2) of several elements represented according to the second representation (E2) and of several elements represented according to the first representation (E1).

5

5. The pattern as claimed in either of claims 3 and 4, wherein said groups (G1, G2) of elements comprise the same number of elements represented according to one of the representations (E1).

10

6. The pattern as claimed in one of claims 1 to 5, wherein at least one valid state of at least one symbol of said pattern represents an item of digital information.

15

7. The pattern as claimed in claim 6, wherein the valid states of each symbol represent respectively binary values of an item of digital information.

20

8. An article comprising at least one pattern as claimed in one of claims 1 to 7.

9. The article as claimed in claim 8, comprising several patterns that are all identical or all different.

25

10. The article as claimed in claim 8, comprising several identical patterns and several different patterns.

30

11. The article as claimed in one of claims 8 to 10, which is chosen from a can, a foil, a cartridge, a capsule containing a comestible substance, a bottle stopper, a banknote, a passport, a security document, a label, a card, a voucher, a pharmaceutical pill, a watch, a package, a semiconductor or a computer peripheral.

12. A method for the marking of an article with an identifying pattern that may contain an item of information relating to the article and/or its use, characterized in that it comprises the following steps:

5 - an alphabet (AT1, AT2) consisting of several symbols is defined;

 - for each symbol, at least two valid states and at least one invalid state are defined;

 - a reference pattern (P1, P2) comprising a set of symbols of the aforementioned alphabet is generated (S1);

10 - at least one representation (P1', P2') of said reference pattern is generated (S2) by assigning a specific valid state to each symbol of the reference pattern; and

 - a marking reproducing said representation of the reference pattern is applied (S3) to the article.

15

13. The method as claimed in claim 12, wherein each symbol is represented by at least two elements having a first possible representation (E1) and a second possible representation (E2).

20

14. The method as claimed in either of claims 12 and 13, wherein each valid state comprises a group of at least one element represented according to the first representation and of at least one element represented according to the second representation, each valid state of one symbol being different from a valid state of another symbol.

25

15. The method as claimed in claim 14, wherein each invalid state of a symbol is different from the valid states of any one of the symbols.

30

16. The method as claimed in one of claims 12 to 15, wherein the valid states of all the symbols are represented by a group of elements comprising the same number of elements.

17. A method for the identification of an identifying pattern applied on an article and possibly containing an item of information relating to the article and/or its use, characterized in that it comprises the following steps:

- 5 - an image of an area of the article, on which at least part of a representation of at least one stored reference pattern appears, is captured (D1), said pattern comprising an arrangement of several symbols belonging to a stored alphabet, each symbol comprising at least two valid states and at least one invalid state and each
10 representation of a symbol in said arrangement corresponding to a valid state of said symbol, and the captured image is stored;
 - the symbols of the stored symbol alphabet are identified (D2) by comparing the captured image with the arrangement of representations of symbols of the stored reference pattern;
 - 15 - the number of identified symbols, represented in a valid state and arranged according to the arrangement of said stored reference pattern, is calculated (D3);
 - the result of the calculation is compared with a probability threshold; and
 - 20 - an identification signal is transmitted if the result reaches said threshold.

18. The identification method as claimed in claim 17, wherein
25 a first symbol in a first position of the arrangement of the stored reference pattern is defined; a representation of at least one valid state of said first symbol is sought in the captured image; if this representation is found, it is considered that the selected symbol is identified; another symbol in another position of the arrangement of the stored reference pattern is then defined; and the previous searching
30 step is repeated for this other symbol in this other position, and so on until all the symbols of the stored reference pattern have been identified or not.

19. The identification method as claimed in claim 18, which includes a step of deciphering at least one item of digital information represented by at least one valid state of at least one symbol of the identifying pattern, which comprises identifying said item of digital
5 information from at least one valid state of at least one identified symbol.