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(71) Demandeur/Applicant:
GIESECKE & DEVRIENT GMBH, DE

(72) Inventeurs/Inventors:
GREGAREK, ANDRE, DE;
HEIM, MANFRED, DE;
RENNER, PATRICK, DE

(74) Agent: R. WILLIAM WRAY & ASSOCIATES

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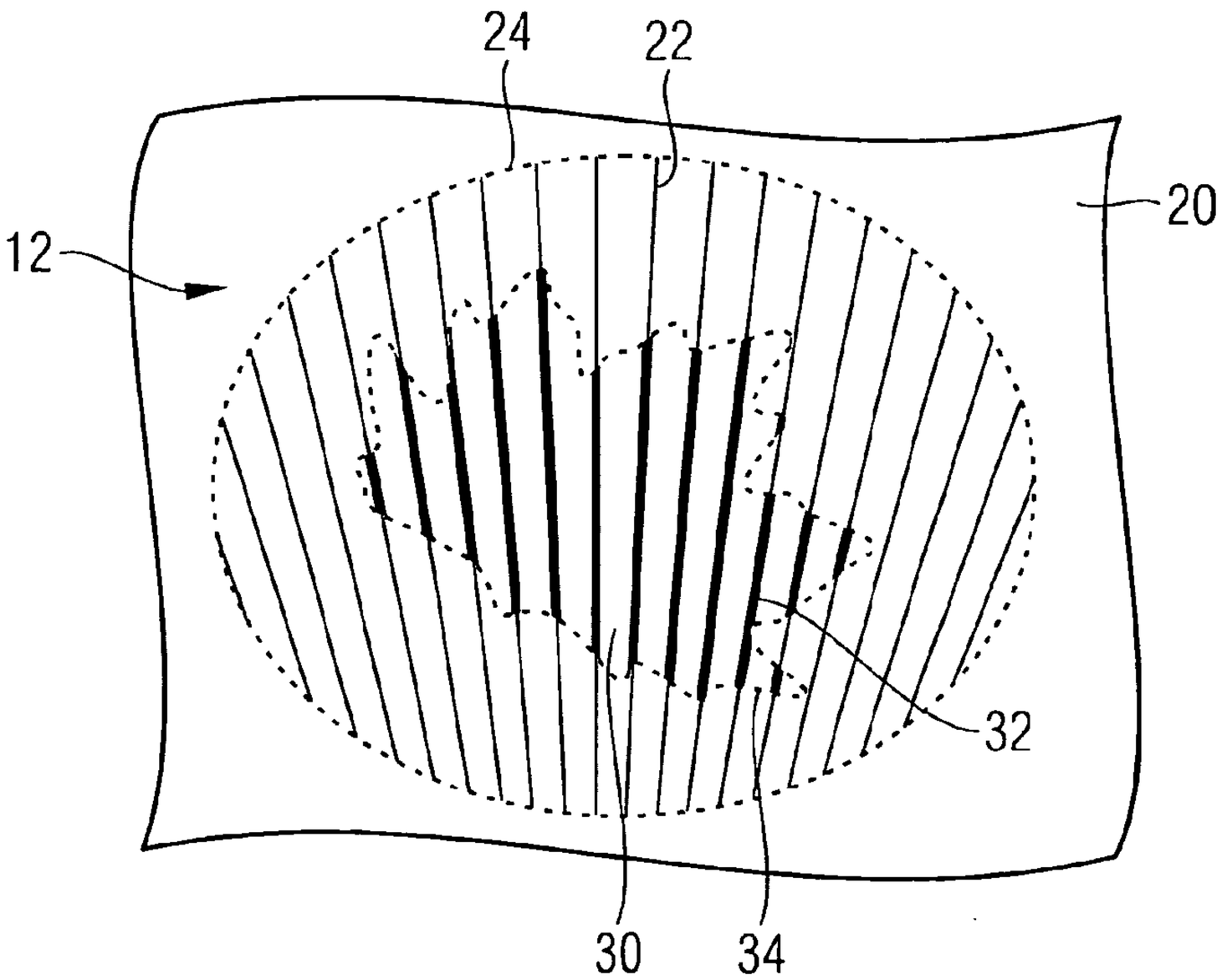

Fig. 2

(57) Abrégé/Abstract:
The invention relates to a data carrier, more particularly a valuable document, such as a banknote, identity card and the like, comprising a substrate (20), in which a feature region (12) is formed by a set of curves made from a plurality of curved and/or diverging sectional lines (22), wherein a visually detectable and/or machine-detectable identification (30) in the form of a pattern, of characters or of a coding is arranged within the feature region (12).

Abstract

The invention relates to a data carrier, more particularly a valuable document, such as a banknote, identity card and the like, comprising a substrate (20), in which a feature region (12) is formed by a set of curves made from a plurality of curved and/or diverging sectional lines (22), wherein a visually detectable and/or machine-detectable identification (30) in the form of a pattern, of characters or of a coding is arranged within the feature region (12).

Data Carrier Having a Feature Region

The present invention relates to a data carrier, especially a value document, such as a banknote, identification card and the like, having a feature region, and a method for manufacturing such a data carrier.

For protection, data carriers, such as security, value or identification documents, but also other valuable objects, are often furnished with security features that permit the authenticity of the data carrier to be verified, and that simultaneously serve as protection against unauthorized reproduction. Here, see-through security features, such as see-through windows in banknotes, are increasingly becoming more attractive. For window production, here, a foil provided with an adhesive layer on one side, for example, is applied to a banknote to close a previously produced through opening in the banknote.

Proceeding from this, it is the object of the present invention to further improve data carriers of the kind cited above with a view to their security against reproduction and their visual appearance.

This object is solved by the data carrier and the manufacturing method having the features of the independent claims. Developments of the present invention are the subject of the dependent claims.

According to the present invention, a generic data carrier, especially a value document, such as a banknote, identification card and the like, includes a substrate in which a feature region is formed by a family of curves composed of a plurality of curved and/or diverging cutting lines, within this feature region, a visually and/or machine-perceptible identifying mark being arranged in the form of a pattern, characters or a code.

Here, the curvature of the cutting lines can be constant, like an arc, decrease or increase along the cutting lines, or also undulate, as in a wave pattern. Divergent straight cutting lines exhibit, not a constant, but rather an increasing distance from each other, the direction in which the distance increases being arbitrary in the context of the present invention. Curved cutting lines can run equidistantly, can run divergently, or can also run with different distance behaviors in some regions.

The identifying mark is preferably formed by a family of curves composed of a plurality of curved and/or diverging cutting lines, such that the cutting lines of the identifying mark form first cutting lines, and the cutting lines of the feature region that lie outside the identifying mark form second cutting lines, the first and second cutting lines connecting to each other and exhibiting different cutting widths. Due to the different cutting widths of the first and second cutting lines and the resulting different areal coverage, within the surrounding see-through region, the identifying mark is visually perceptible in transmitted light and/or reflected light, or in the event of a covering by opaque cover layers, machine detectable.

Here, the width of the first cutting lines can be both larger and smaller than the width of the second cutting lines. The wider cutting lines here are especially at least 10%, at least 20%, at least 50% or even more than 100% wider than the narrower cutting lines. In advantageous embodiments, the cutting width of the first and second cutting lines is substantially constant in each case. Here, the formulation "substantially constant" accounts for the fact that, in laser cutting, in practice, even with the same settings, the cutting width can vary slightly and thus cannot be completely constant.

In a preferred variant of the present invention, the substrate is provided in the feature region with a laser-modifiable marking substance, and at least the cutting lines of the feature region that lie outside the identifying mark exhibit an edge region that is modified by the action of laser radiation. If cutting lines are likewise present within the identifying mark, then also these advantageously exhibit an edge region that is modified by the action of laser radiation. In other embodiments, the region of the identifying mark is uncut, especially merely provided with marking lines or marking contours, as explained below. The substrate can especially be provided with a marking substance whose visible color is changeable by the action of laser radiation. The cutting lines of the feature region that lie outside the identifying mark, and, if applicable, also the cutting lines that are present within the identifying mark then exhibit a colored edge region.

Alternatively or additionally, the substrate can be provided with a marking substance whose infrared-absorbing, magnetic, electric or luminescent properties are changeable by the action of laser radiation. The cutting lines of the feature region that lie outside the identifying mark and, if applicable, also the cutting lines that are present within the identifying mark then exhibit an edge region having changed infrared-absorbing, magnetic, electric or luminescent properties compared with their surroundings. Such embodiments permit a simple supplementary mechanical authenticity check of the feature region. Of course, variants that permit an authenticity check with the naked eye or simple auxiliary means, such as a UV lamp, are also conceivable.

Advantageously, laser-modifiable effect pigments can be used as the marking substance. Such effect pigments, with different properties, especially with respect to their body color, the color change under laser

action, the threshold energy and the required laser wavelength, are available to the person of skill in the art. Also effect pigments that, upon laser irradiation, do not change (only) their visible color, but rather their infrared-absorbing, magnetic, electrical or luminescent properties, are known to the person of skill in the art. The modification of the effect pigments can be done with laser radiation in the ultraviolet, visible or infrared spectral range, for example with a CO_2 laser of a wavelength of 10.6 µm.

In a further, likewise advantageous variant of the present invention, a pigment-free laser-modifiable marking substance is used. Also pigment-free marking substances can be applied to the substrate or introduced into the substrate volume, for example as intaglio or printing ink. With pigment-free marking substances, it is possible to produce a high-transparency coating into which a permanent and high-contrast identifying mark can be introduced by laser action at high speed. Pigment-free marking substances can be modified by laser radiation in the ultraviolet, visible or infrared spectral range, for example with the 10.6 µm radiation of a CO_2 laser. Specific, non-limiting examples of pigment-free laser-modifiable marking substances are specified in publications WO 02/101462 A1, US 4,343,885 and EP 0 290 750 B1. Especially also the laser-markable compositions specified in publication EP 1 648 969 B1 that are modifiable with a CO_2 cutting laser can be used as marking substances.

In a further, likewise advantageous variant of the present invention, the identifying mark is formed by an uncut region of the substrate. The identifying mark is then easily perceptible against the background of the screened feature region, especially in transmitted light.

According to a further advantageous variant of the present invention, the identifying mark is formed by an uncut region of the substrate having a family of marking curves composed of a plurality of marking lines that connect to the cutting lines outside the identifying mark. In general, in the context of this description. the term "marking lines" always refers to uncut, merely marked lines. Lines that exhibit both an inner cutting region and an outer marking region are likewise possible and are referred to as (colored) edged cutting lines or cutting lines having a (colored) edge.

In this variant of the present invention, the identifying mark is easily perceptible in transmitted light as an uncut portion of the substrate, and is clearly visible also in top view due to the marking lines.

Here, the substrate is preferably provided with a marking substance whose visible color is changeable by the action of laser radiation, such that the marking lines of the identifying mark are colored. Alternatively or additionally, the substrate can also be provided with a marking substance whose infrared-absorbing, magnetic, electric or luminescent properties are changeable by the action of laser radiation, such that the marking lines of the identifying mark exhibit changed infrared-absorbing, magnetic, electric or luminescent properties compared with their surroundings. Here, too, the above-mentioned substances may be used as marking substances.

Given suitable laser parameters, a colored marking line can also be produced without an additional marking substance, for example in that, through combustion processes, the paper fibers discolor, or in that the opacity of a polymer substrate changes.

In a further advantageous variant of the present invention, the identifying mark is formed by an uncut region of the substrate having multiple nested marking contours of decreasing size. Here, the marking contours expediently trace the shape of the identifying mark, with all details of the outer contour of the identifying mark, with increasing diminution, no longer having to be depicted. Also in such an embodiment, the identifying mark having the depicted marking motif is clearly perceptible in reflected light.

As with the preceding variant of the present invention, also in this variant, the substrate can be provided with a marking substance whose visible color and/or whose infrared-absorbing, magnetic, electric or luminescent properties are changeable by the action of laser radiation, such that the marking contours exhibit appropriately changed properties.

In all embodiments, a through motif opening can be arranged within the motif region in the form of a pattern, characters or a code. In advantageous embodiments, the shape of the motif opening and the shape of the identifying mark are associated in meaning. Such a meaning association can especially consist in that the motif opening depicts the same motif as the identifying mark, with it being possible for the spatial position and/or the size of the two depicted motifs to differ. The meaning association can also consist in that the first and second depicted motif each form only motif portions that complement each other to form a complete motif, or in that the first and second depicted motif complement each other to form a coherent complete image.

Also the feature region itself can, in all embodiments, be developed in the form of a pattern, characters or a code, it being possible for the shape of the feature region and the shape of the identifying mark and/or, if applicable, an

existing motif opening to be associated in meaning. The shapes of the feature region, identifying mark and motif opening can, however, also be chosen to be independent of one another, and each depict independent motifs.

In a development of the present invention, the feature region exhibits, in addition to the family of curves composed of the plurality of curved and/or diverging cutting lines, also a family of marking curves composed of a plurality of marking lines, preferably composed of a plurality of curved and/or diverging marking lines. Here, the cutting lines and the marking lines can include an arbitrary angle to one another. In this development, the identifying mark is advantageously formed by an uncut region of the substrate having two families of marking curves each composed of a plurality of marking lines, the marking lines of the one family of marking curves connecting to the cutting lines outside the identifying mark, and the marking lines of the other family of marking curves connecting to the marking lines outside the identifying mark.

According to a further advantageous variant of the present invention, the outline of the identifying mark is provided with a marking contour, especially a colored marking contour, to increase the perceptibility of the identifying mark in reflected light.

In all embodiments, the cutting lines are preferably developed having a width between 0.05 mm and 1 mm. The center-to-center distance is preferably between 0.05 mm and 3 mm, especially between 0.5 mm and 1.5 mm, the center-to-center distance being able to be constant (equidistant cutting lines) or variable (diverging cutting lines). In cutting lines having an edge region, the width of the edge region on each side is preferably between

0.02 mm and 1 mm, and pure marking lines without a cutting region preferably exhibit a width between 0.05 mm and 3 mm.

In an advantageous variant of the present invention, the family of curves of the feature region is formed from a plurality of curved, equidistant cutting lines. In another, likewise advantageous variant of the present invention, the family of curves of the feature region is formed from a plurality of straight, diverging cutting lines.

In one expedient development of the present invention, the relative arrangement of the family of cutting line curves and identifying mark forms a further authenticity feature for which, for different specimens of the data carrier, different relative arrangements of the family of cutting line curves and identifying mark are selectable.

The feature region of the data carrier is advantageously reinforced by a foil element. Here, the foil element can include a family of curves that, with the family of curves of the feature region, produces a moiré effect. For example, the center-to-center distance of the family of curves of the foil element can deviate slightly (for example a few percent) from the center-to-center distance of the family of curves of the feature region, and/or the two families of curves can be rotated slightly (for example by a few degrees) against each other.

However, it is also possible to use a feature region without an additional foil element as the security element. The data carrier can especially be a security element, a security paper or a value document.

In one advantageous variant of the present invention, the feature region forms a see-through region in which the identifying mark produces, in reflected light and/or transmitted light, a changed visual appearance with respect to the rest of the feature region.

According to another, likewise advantageous variant of the present invention, the feature region is covered on one or both data carrier sides with a cover layer of low transmittance, such that the identifying mark is substantially not visible in reflected light and stands out only when viewed in transmitted light.

Finally, according to a further advantageous variant of the present invention, the feature region can be covered on both data carrier sides with an opaque cover layer, such that the identifying mark is not visually visible, but is machine perceptible, for example through ultrasound.

The present invention also includes a method for manufacturing a data carrier of the kind cited above. Here, a feature region is formed in the substrate in that, through laser cutting, a family of curves composed of a plurality of curved and/or diverging cutting lines is produced, and within the feature region, a visually and/or machine-perceptible identifying mark being produced in the form of a pattern, characters or a code.

The identifying mark is preferably formed by a family of curves composed of a plurality of curved and/or diverging first cutting lines that are produced by the same cutting laser beam as the second cutting lines of the feature region that lie outside the identifying mark, and in that the first and second cutting lines are produced having different cutting widths by a variation in the laser parameters, especially in the laser power and/or the cutting speed.

In an advantageous method variant, the substrate is provided in the feature region with a laser-modifiable marking substance such that the cutting lines that lie outside the identifying mark are modified in their edge region by the action of laser radiation. Preferably also the cutting lines that lie within the identifying mark are modified in their edge region by the action of laser radiation.

According to a further advantageous procedure, the identifying mark is formed by an uncut region of the substrate, preferably the identifying mark is formed by an uncut region of the substrate having a family of marking curves composed of a plurality of marking lines that are produced by the same laser beam as the cutting lines that lie outside the identifying mark of the see-through region, and the cutting lines that lie outside the identifying mark and the marking lines of the identifying mark are produced by a variation in the laser parameters, especially the laser power and/or the cutting speed.

Further exemplary embodiments and advantages of the present invention are explained below by reference to the drawings, in which a depiction to scale and proportion was omitted in order to improve their clarity.

Shown are:

Fig. 1 a schematic diagram of a banknote having a feature region according to the present invention,

Fig. 2 a detailed top view of the feature region of the banknote in fig. 1,

Fig. 3 in (a), a sketch to explain the change in the cutting width with cutting laser beams having maximum powers of different extremes, and in (b), a detailed cutout of fig. 2 at the edge of the identifying mark,

Fig. 4 a top view of a see-through region according to another exemplary embodiment of the present invention,

Fig. 5 a top view of a see-through region according to a further exemplary embodiment of the present invention,

Fig. 6 a detailed diagram like fig. 3(b) at the edge of an identifying mark for a further exemplary embodiment of the present invention,

Fig. 7 schematically, the spatial energy distribution of a cutting laser beam to explain the creation of the edge effect,

Fig. 8 a detailed diagram at the edge of an identifying mark according to a further exemplary embodiment of the present invention,

Fig. 9 a detailed diagram at the edge of an identifying mark according to yet a further exemplary embodiment of the present invention,

Fig. 10 in (a) and (b), two specimens of a banknote that differ in the relative arrangement of the family of cutting line curves and the identifying mark, and

Fig. 11 a data carrier according to a further exemplary embodiment of the present invention, whose identifying mark is not visible visually and is only machine detectable.

The invention will now be explained using a banknote as an example. For this, figures 1 and 2 show a schematic diagram of a banknote 10 that exhibits an inventive feature region in the form of a see-through region 12, shown in greater detail in fig. 2.

With reference to the top view in fig. 2, the feature region 12 is formed by a family of curves composed of a plurality of straight, diverging cutting lines 22 that were cut in the banknote paper 20 by the action of laser radiation. In the exemplary embodiment, the family of curves of the cutting lines 22 exhibits a cutting width of 0.15 mm, and the center-to-center distance of the cutting lines is between 0.4 mm at the lower edge and 1.0 mm at the upper edge of the see-through region 12. The areal coverage of the cutting lines is thus between 15% and 37.5%, so that the see-through region 12 is perceptible both in top view and when looked through.

The see-through region 12 is developed in the form of a geometric pattern, for example the oval depicted in fig. 2. Its outline is indicated in the figure by the border 24 drawn in with dotted lines, and serves merely to graphically illustrate the shape formed.

Within the see-through region 12 is arranged an identifying mark 30 that, compared with the surrounding see-through region 12, exhibits a changed visual appearance in reflected light and/or transmitted light and, because of this, is perceptible for a viewer. The identifying mark 30 is generally developed in the form of a pattern, characters or a code and, in the exemplary embodiment, has the shape of a maple leaf. Also the outline 34 of the identifying mark 30, drawn in with dotted lines, serves merely to graphically illustrate its shape and does not necessarily correspond to an actually existing contour on the banknote.

In the exemplary embodiment in fig. 2, also the identifying mark 30 is formed by a family of curves composed of a plurality of straight, diverging cutting lines 32, the cutting lines 32 of the identifying mark 30 connecting in perfect registration with the cutting lines 22 that lie outside the identifying mark of the see-through region 12. However, the cutting lines 32 within the identifying mark 30 are developed having a cutting width of 0.3 mm and are thus substantially wider than the cutting lines 22 that are present outside the identifying mark. Due to the lower areal coverage of the paper in the region of the identifying mark 30, the "maple leaf" motif formed by it is, depending on the lighting conditions and the background, clearly perceptible in reflected light and/or transmitted light.

The perfect registration of the cutting lines 22, 32 of different widths is ensured by producing the cutting lines 22, 32 by laser cutting with the same cutting laser beam in the same operation. The different cutting widths are produced by a variation in the laser parameters, especially a variation in the laser power and/or the cutting speed, in the cutting process.

For illustration, the substantially Gaussian spatial distribution of the power W of a cutting laser beam is shown in fig. 3(a). At a constant cutting speed and high maximum power (distribution 40), the energy input of the laser radiation into the paper exceeds the threshold energy required to cut the paper 20 in a wide cutting region 42. For a distribution 44 with a lower maximum power, in contrast, the threshold energy required to cut the paper 20 is exceeded only in a narrower cutting region 46, such that a smaller cutting width results. In this way, at a constant cutting speed, due to the practically instantaneously possible variation in the laser power, the cutting width of the laser beam can be varied as desired along the laser beam path.

With reference to fig. 2 and the detailed diagram in fig. 3(b), in this way, cutting lines 22, 32 that are connected to each other can be produced in a single operation as through, and thus perfectly registered, cutting lines. For this, at the transition from the see-through region 12 (cutting lines 22) to the region of the identifying mark 30 (cutting lines 32), the laser power and thus the cutting width is increased, and at the transition from the region of the identifying mark 30 (cutting lines 32) to the see-through region 12 (cutting lines 22), the laser power and thus the cutting width is decreased again. This is particularly easy to perceive in the detailed cutout in fig. 3(b), which shows the transition of a wide cutting line 32 within the identifying mark 30 (width 42, here 0.3 mm) to a narrow cutting line outside the identifying mark (width 46, here 0.15 mm) exactly at the edge 34 of the identifying mark 30.

The change in the cutting width 42, 46 can also be achieved through a change in the cutting speed at constant laser power. At a high cutting speed, the laser radiation acts only relatively briefly on the paper, such that the energy input into the paper is low. Accordingly, the threshold energy required to cut the paper is exceeded with high laser power only in a narrow cutting

region. At a lower cutting speed, in contrast, the laser radiation acts on the paper longer, such that a higher energy input into the paper results. Accordingly, a wider cutting region results in that the threshold energy required to cut the paper is exceeded. Both parameters, laser power and cutting speed, can, of course, also be changed together and simultaneously to have a greater breadth of variation available.

The exemplary embodiment in fig. 4 shows a see-through region 50 in which the cutting lines 52 that lie outside the identifying mark 54 were produced, as in fig. 2, by laser cutting. In contrast to fig. 2, the family of curves of the see-through region 50 is formed by curved, equidistant cutting lines 52. Further, within the identifying mark 54, the laser power of the cutting laser was reduced below the cutting threshold of the paper 20, such that no cutting lines were produced there. In this way, the identifying mark 54 remains as an uncut piece of paper and is clearly perceptible against the background of the screened feature region 50, especially in transmitted light.

Fig. 5 shows a further exemplary embodiment of the present invention having a see-through region 60 for which the family of curves of the cutting lines that lie outside the identifying mark 64 is formed by curved and diverging cutting lines 62. Fig. 5 further illustrates the optional marking of the outer contour 66 of the identifying mark 64 with the aid of the laser radiation. For this, as described in greater detail below, the banknote paper 20 was provided with a laser-modifiable marking substance whose visible color is modifiable by the action of laser radiation. To produce the outer contour 66, the laser parameters were then set such that the laser energy is below the cutting threshold of the paper across the entire beam diameter, but in an inner region, is still above the reaction threshold of the laser-modifiable marking substance and thus induces a desired color change.

Fig. 6 shows, in a detailed diagram like fig. 3(b), an exemplary embodiment of an advantageous variant of the present invention in which the see-through region 70 and the identifying mark 80 are both formed by a plurality of curved and/or diverging cutting lines 72 or 82. The cutting lines 72, 82 connect with each other in perfect register at the edge 86 of the identifying mark, the cutting width of the cutting lines 72 outside the identifying mark 80 being chosen, as in the exemplary embodiment in fig. 2, to be smaller than the cutting width of the cutting lines 82 within the identifying mark 80 through suitable variation of the laser parameters. In addition, both the cutting lines 82 within the identifying mark and the cutting lines 72 outside the identifying mark are each surrounded on both sides of a perfectly registered colored edge 74 or 84.

To produce such a colored edge 74, 84 that is perfectly registered with the cutting lines, before the laser cutting, the banknote paper 20 was provided, in certain surroundings of the see-through region 70 to be produced, with a laser-modifiable feature substance, for example with laser-modifiable effect pigments that, upon the action of laser radiation, display a desired color change, for instance from colorless to red.

The principle of the simultaneously and perfectly registered production of the cutting lines 72, 82 and of the colored edges 74, 84 is illustrated in fig. 7, where the spatial power or energy distribution 90 of the cutting laser beam is shown schematically. In an inner region, the cutting region 92, the laser energy exceeds the threshold energy E_1 required to cut the paper 20. In fig. 7, the reaction energy of the effect pigments is indicated by E_2, upon the exceedance of which the desired color change occurs. As directly evident from the drawing, in an outer region of the laser beam profile, the marking

region 94, the laser energy is between the reaction energy E_2 required for the color change and the energy E_1 required for cutting, such that, in the marking region 94, a color change is induced in the effect pigments, but the substrate is not cut.

The banknote paper 20 that is provided with the laser-modifiable effect pigments is thus cut by the laser beam 90 in a central region 72 or 82 that corresponds to the cutting region 92 in fig. 7, and additionally colored in an edge region 74, 84, in perfect register with the cutting lines 72 and 82. Here, the width of the colored edge region 74, 84 corresponds to the width of the marking region 94 and depends on the beam profile, the reaction energy of the effect pigments used, and the material properties of the paper. Outside the cutting region 92 and the marking region 94, the laser energy is below the reaction threshold of the effect pigments, such that the paper is not changed there.

To make the outline of an identifying mark better perceptible in reflected light, the outer contour 66 of the identifying mark 64 can be marked with the aid of the laser radiation, as illustrated in fig. 5. For this, the laser parameters are set such that the laser energy is below the cutting threshold of the paper across the entire beam diameter, but in an inner region is still above the reaction threshold of the effect pigments, for example through the choice of a laser energy between E_1 and E_2 in fig. 7.

Fig. 8 shows a further exemplary embodiment of a see-through region 100 according to the present invention, in which the cutting lines 102 that lie outside the identifying mark 110 are produced, as in fig. 6, by laser cutting a banknote paper 20 provided with a marking substance, together with a registered colored edge 104. However, unlike the exemplary embodiment in

fig. 6, the laser parameters of the cutting laser were varied at the transition into the region of the identifying mark 110 in such a way that the energy input into the paper is below the cutting threshold of the paper 20, but still above the reaction threshold of the marking substance. In this way, the laser beam no longer produces cutting lines having a colored edge within the identifying mark 110, but rather just colored marking lines 112 that connect in perfect registration with the cutting lines 102 at the edge 116 of the identifying mark 110. Such a registered transition from colored marking lines to colored-edged cutting lines is visually attractive, easy to detect and, moreover, poses a technical obstacle that is difficult for a counterfeiter to overcome.

A further embodiment variant is depicted in the detailed cutout in fig. 9. The exemplary embodiment shown there includes a see-through region 120 that, outside an identifying mark 130, exhibits both a family of curves composed of cutting lines 122 having a colored edge 124 and a family of marking curves composed of colored marking lines 126 without a cutting region. Both the cutting lines 122 and the marking lines 126 can be, for example, curved and equidistant, curved and diverging, or straight and diverging. At the edge of the identifying mark 130, both the colored marking lines 126 and the colored-edged cutting lines 122 transition in perfect register into colored marking lines 132.

In the exemplary embodiment shown, both line types 122, 126 of the see-through region 120 are arranged alternatingly, but also other sequences, for example of two cutting lines 122 each and one marking line 126, are conceivable. Since the family of marking curves includes no cutting lines, it can also be arranged at an arbitrary angle to the family of curves of the cutting lines.

In all of the embodiments shown, the relative arrangement of the family of cutting line curves and the identifying mark can form a further authenticity feature. For this, relative to the identifying mark, the family of cutting line curves is arranged differently for different specimens of the data carrier, and this different arrangement correlates with a further characteristic of the data carrier, for example the serial number.

For illustration, fig. 10 shows, in (a) and (b), two specimens of a banknote in which a see-through region 140 is formed by curved, equidistant cutting lines 142, as already explained in principle in connection with fig. 4. In the region of an identifying mark 144, which here is designed in the form of the denomination "10" of the banknote, the laser power of the cutting laser was lowered below the cutting threshold of the paper such that no cutting lines were produced there.

The two banknote specimens in figures 10(a) and (b) now differ in the phase relation of the curved cutting lines 142 relative to the identifying mark 144. While, in fig. 10(a), the curvature bulges of the cutting lines 142 point left at the upper edge of the identifying mark 144 (arrangement 1, reference sign 146), in fig. 10(b), they point right there (arrangement 2, reference sign 148). The phase relation of the cutting lines 142 can now, for example, be chosen in accordance with the serial number of the appropriate banknote specimen, for instance arrangement 1 for the serial number range 0000001 to 0100000, arrangement 2 for the serial number range 0100001 to 0200000, thereafter arrangement 1 again for the serial number range 0200001 to 0300000, and so on. Through a visual or machine check of the phase relation of the cutting lines 142 and a comparison with the allocation to the serial numbers, the authenticity of the note can then be verified. In practice, advantageously, a

complicated allocation between the serial numbers and the relative arrangement is chosen such that, as long as the allocation of the serial numbers is kept secret, it is not comprehensible for a potential counterfeiter which arrangement is allocated to which serial numbers.

Instead of a different phase relation, also other features of the family of cutting line curves can be used for encoding, for example the slope (upward/downward), the divergence (opening upward/downward or right/left) or the radius of curvature (increasing/decreasing).

If the feature region is covered on one or both sides of the data carrier with a cover layer of low transmittance, then the identifying mark is practically not perceptible in reflected light, but stands out clearly when the data carrier is viewed in transmitted light.

The feature region can also be designed such that the identifying mark is completely not visible visually and is only machine detectable. For this, fig. 11 shows, in cross section, a data carrier according to the present invention, in which a transparent foil 150 is covered on both sides by opaque cover layers 152. The foil 150 includes a feature region 154 having a plurality of curved and/or diverging cutting lines 156 and an identifying mark 158 arranged within the feature region. The identifying mark 158 can, as in fig. 11, be formed by an uncut region of the foil 150 or, in other embodiments, can, for example, be formed by a region having cutting lines of another width.

Since the foil 150 is covered on both sides by opaque cover layers 152, the cutting lines 156 and thus also the identifying mark 158 are visually not perceptible. The identifying mark 158 can, however, be machine detected, for

example by an ultrasound sensor 160. It is appropriate to combine the identifying marks that are only machine-perceptible with a code, due to the relative arrangement of the family of cutting line curves and the identifying mark, as already explained in principle in connection with fig. 10.

List of Reference Signs

10 Banknote

12 See-through region

20 Banknote paper

22 Cutting lines

24 Border

30 Motif region

32 Cutting lines

34 Outline

40 Distribution

42 Cutting region

44 Distribution

46 Cutting region

50 See-through region

52 Cutting lines

54 Identifying mark

60 See-through region

62 Cutting lines

64 Identifying mark

66 Outer contour

70 See-through region

72 Cutting lines

74 Colored edge

80 Identifying mark

82 Cutting lines

84 Colored edge

86 Edge of the identifying mark

90 Energy distribution

92 Cutting region

94 Marking region

110 See-through region

102 Cutting lines

104 Colored edge

110 Identifying mark

112 Marking lines

116 Edge of the identifying mark

120 See-through region

122 Cutting lines

124 Colored edge

126 Marking lines

130 Identifying mark

132 Marking lines

140 See-through region

142 Cutting lines

144 Identifying mark

146, 148 Curvature bulges

150 Foil

152 Cover layers

154 Feature region

156 Cutting lines

158 Identifying mark

160 Ultrasound sensor

Claims

1. A data carrier, especially a value document, such as a banknote or identification card, having a substrate in which a feature region is formed by a family of curves composed of a plurality of curved and/or diverging cutting lines, a visually and/or machine-perceptible identifying mark in the form of a pattern, of characters or a code being arranged within the feature region, and the identifying mark being formed by an uncut region of the substrate having a family of marking curves composed of a plurality of marking lines that connect with the cutting lines outside the identifying mark.

2. The data carrier according to claim 1, **characterized in that** the outline of the identifying mark is provided with a marking contour, especially a colored marking contour.

3. A data carrier, especially a value document, such as a banknote or identification card, having a substrate in which a feature region is formed by a family of curves composed of a plurality of curved and/or diverging cutting lines, a visually and/or machine-perceptible identifying mark in the form of a pattern, of characters or a code being arranged within the feature region, and the identifying mark being formed by a family of curves composed of a plurality of curved and/or diverging cutting lines, such that the cutting lines of the identifying mark form first cutting lines and the cutting lines of the feature region that lie outside the identifying mark form second cutting lines, the first and second cutting lines connecting with each other and exhibiting different cutting widths.

4. The data carrier according to at least one of claims 1 to 3, **characterized in that** the substrate is provided in the feature region with a laser-modifiable marking substance, and in that the cutting lines of the feature region that lie outside the identifying mark exhibit an edge region that is modified by the action of laser radiation, preferably in that the substrate is provided with a marking substance whose visible color is modifiable by the action of laser radiation, and in that the cutting lines of the feature region that lie outside the identifying mark exhibit a colored edge region.

5. The data carrier according to claim 4, **characterized in that** the identifying mark is formed by a family of curves composed of a plurality of curved and/or diverging cutting lines, such that the cutting lines of the identifying mark form first cutting lines, and the cutting lines of the feature region that lie outside the identifying mark form second cutting lines, the first and second cutting lines connecting with each other, and the first cutting lines and preferably also the second cutting lines exhibiting an edge region that is modified by the action of laser radiation.

6. The data carrier according to at least one of claims 1 to 5, **characterized in that**, within the identifying mark, a through motif opening is arranged in the form of a pattern, characters or a code.

7. The data carrier according to at least one of claims 1 to 6, **characterized in that** the feature region exhibits, in addition to the family of curves composed of the plurality of curved and/or diverging cutting lines, a family of marking curves composed of a plurality marking lines, preferably composed of a plurality of curved and/or diverging marking lines.

8. The data carrier according to at least one of claims 1 to 7, **characterized in that** the cutting lines exhibit a width between 0.05 mm and 1 mm, especially between 0.1 mm and 0.4 mm, and a constant or changing center-to-center distance between 0.05 mm and 1 mm, especially between 0.3 mm and 0.7 mm.

9. The data carrier according to at least one of claims 1 to 8, **characterized in that** the family of curves of the feature region is formed from a plurality of curved, equidistant cutting lines.

10. The data carrier according to at least one of claims 1 to 8, **characterized in that** the family of curves of the feature region is formed from a plurality of straight, diverging cutting lines.

11. The data carrier according to at least one of claims 1 to 10, **characterized in that** the feature region is developed in the form of a pattern, characters or a code.

12. The data carrier according to at least one of claims 1 to 11, **characterized in that** the relative arrangement of the family of cutting line curves and the identifying mark forms a further authenticity feature for which, for different specimens of the data carrier, different relative arrangements of the family of cutting line curves and the identifying mark are selectable.

13. The data carrier according to at least one of claims 1 to 12, **characterized in that** the feature region is reinforced by a foil element.

14. The data carrier according to at least one of claims 1 to 13, **characterized in that** the feature region forms a see-through region in which the identifying mark produces a changed visual appearance in reflected light and/or transmitted light.

15. The data carrier according to at least one of claims 1 to 13, **characterized in that** the feature region is covered on one or both data carrier sides with a cover layer of low transmittance, such that the identifying mark is substantially not visible in reflected light and stands out when viewed in transmitted light.

16. The data carrier according to at least one of claims 1 to 13, **characterized in that** the feature region is covered on both data carrier sides with an opaque cover layer, such that the identifying mark is not visible visually, but is machine-perceptible.

17. The data carrier according to at least one of claims 1 to 16, **characterized in that** the data carrier is a security element, a security paper or a value document.

18. A method for manufacturing a data carrier according to claim 1 that exhibits a substrate into which the feature region is to be introduced, in the method, a feature region being formed in the substrate in that a family of curves composed of a plurality of curved and/or diverging cutting lines is produced by laser cutting, a visually and/or machine-perceptible identifying mark in the form of a pattern, characters or a code being produced within the feature region, and the identifying mark being formed by an uncut region of the substrate having a family of marking curves composed of a plurality of

marking lines that connect with the cutting lines outside the identifying mark.

19. The method according to claim 18, **characterized in that** the marking lines are produced by the same laser beam as the cutting lines that lie outside the identifying mark of the see-through region, and in that the cutting lines that lie outside the identifying mark and the marking lines of the identifying mark are produced by a variation in the laser parameters, especially the laser power and/or the cutting speed.

20. A method for manufacturing a data carrier according to claim 3 that exhibits a substrate into which the feature region is to be introduced, in the method, a feature region being formed in the substrate in that a family of curves composed of a plurality of curved and/or diverging cutting lines is produced by laser cutting, a visually and/or machine-perceptible identifying mark in the form of a pattern, characters or a code being produced within the feature region, and the identifying mark being formed by a family of curves composed of a plurality of curved and/or diverging cutting lines such that the cutting lines of the identifying mark form first cutting lines and the cutting lines of the feature region that lie outside the identifying mark form second cutting lines, the first and second cutting lines connecting with each other and exhibiting different cutting widths.

21. The method according to claim 20, **characterized in that** the first cutting lines are produced by the same cutting laser beam as the second cutting lines of the feature region that lie outside the identifying mark, and in that the first and second cutting lines are produced having different cutting widths by a variation in the laser parameters, especially in the laser power and/or the cutting speed.

22. The method according to at least one of claims 18 to 21, **characterized in that** the substrate is provided in the feature region with a laser-modifiable marking substance, such that the cutting lines that lie outside the identifying mark are modified in their edge region by the action of laser radiation, preferably in that also the cutting lines that lie within the identifying mark are modified in their edge region by the action of laser radiation.

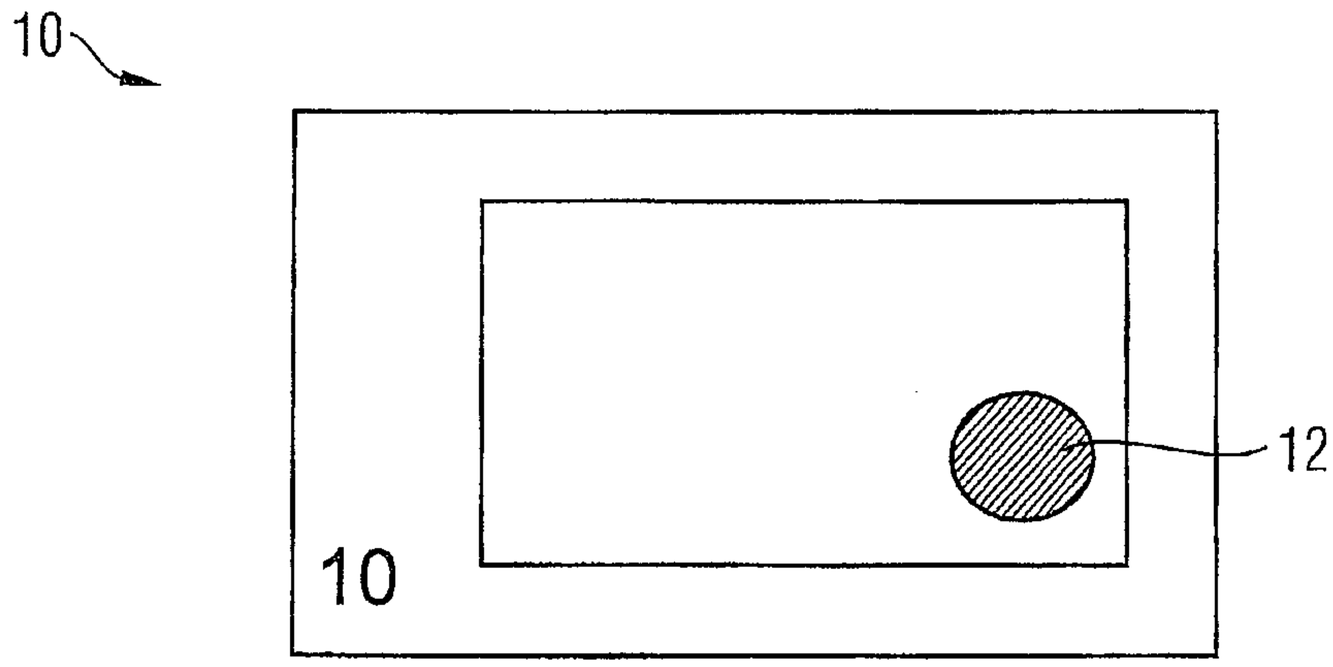

Fig. 1

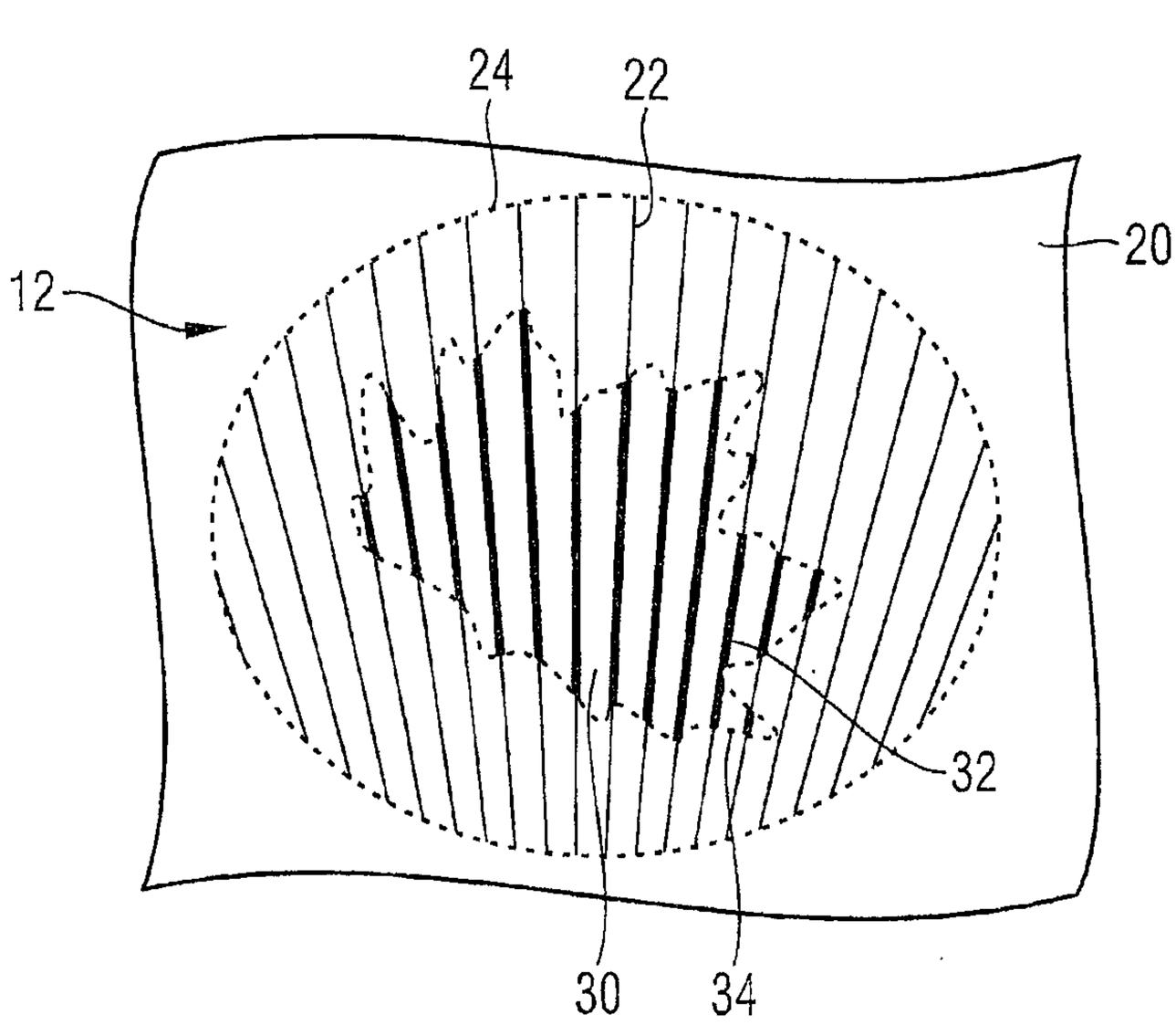

Fig. 2

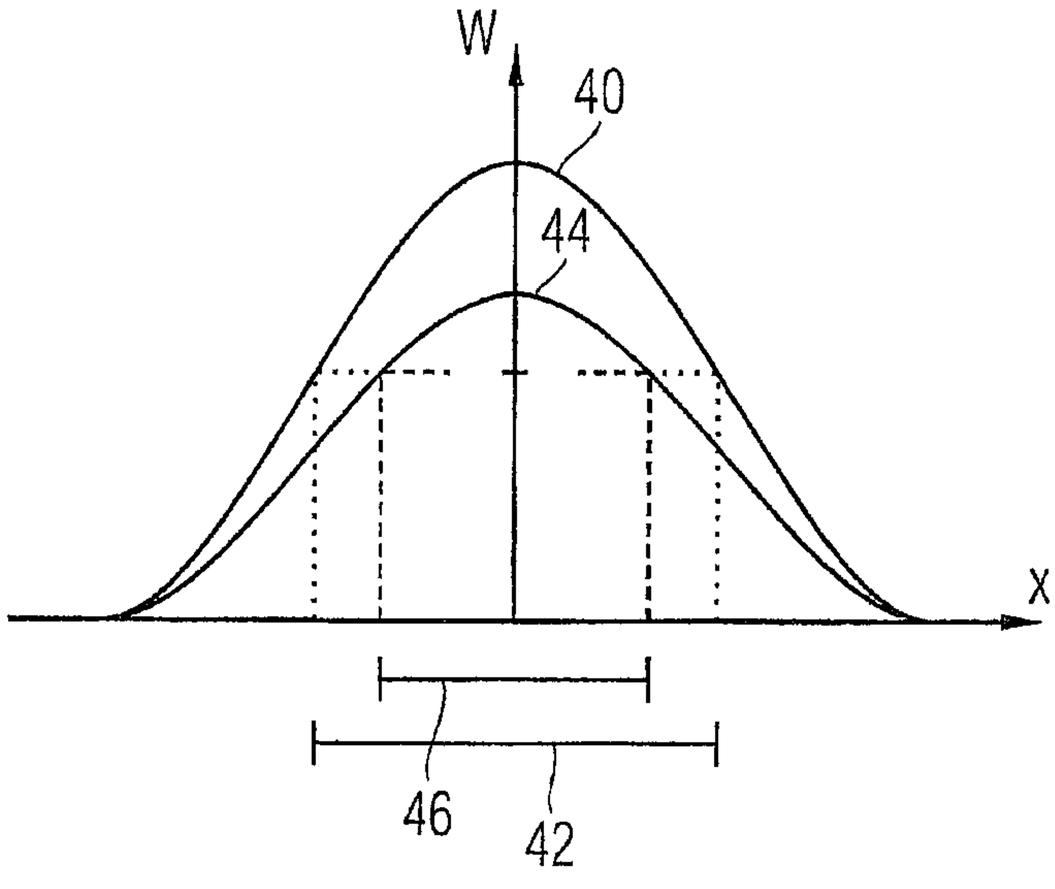

Fig. 3a

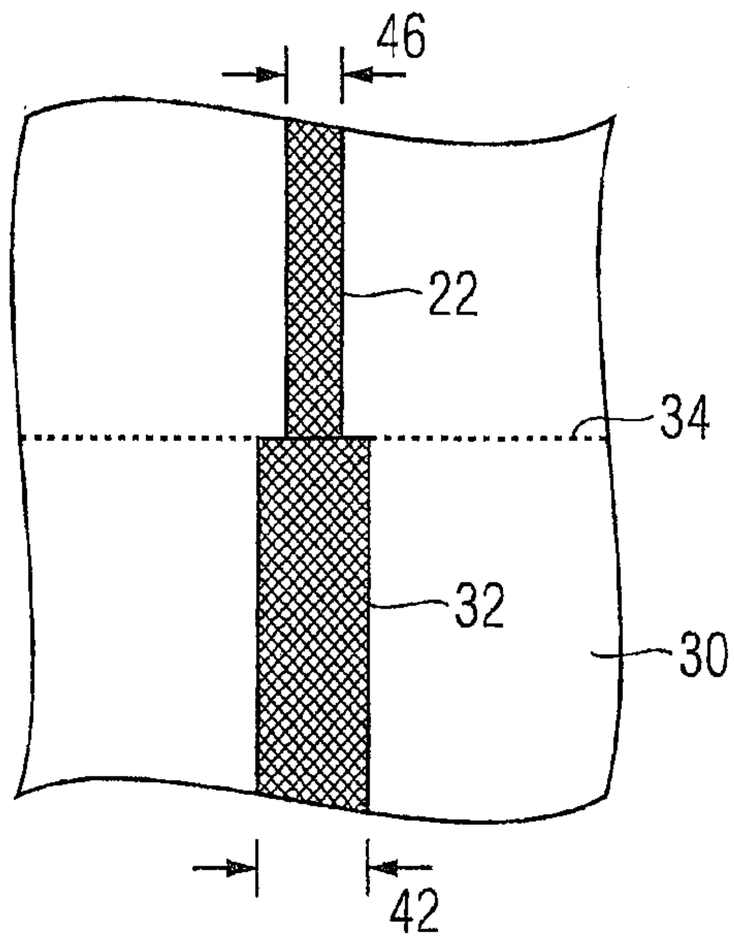

Fig. 3b

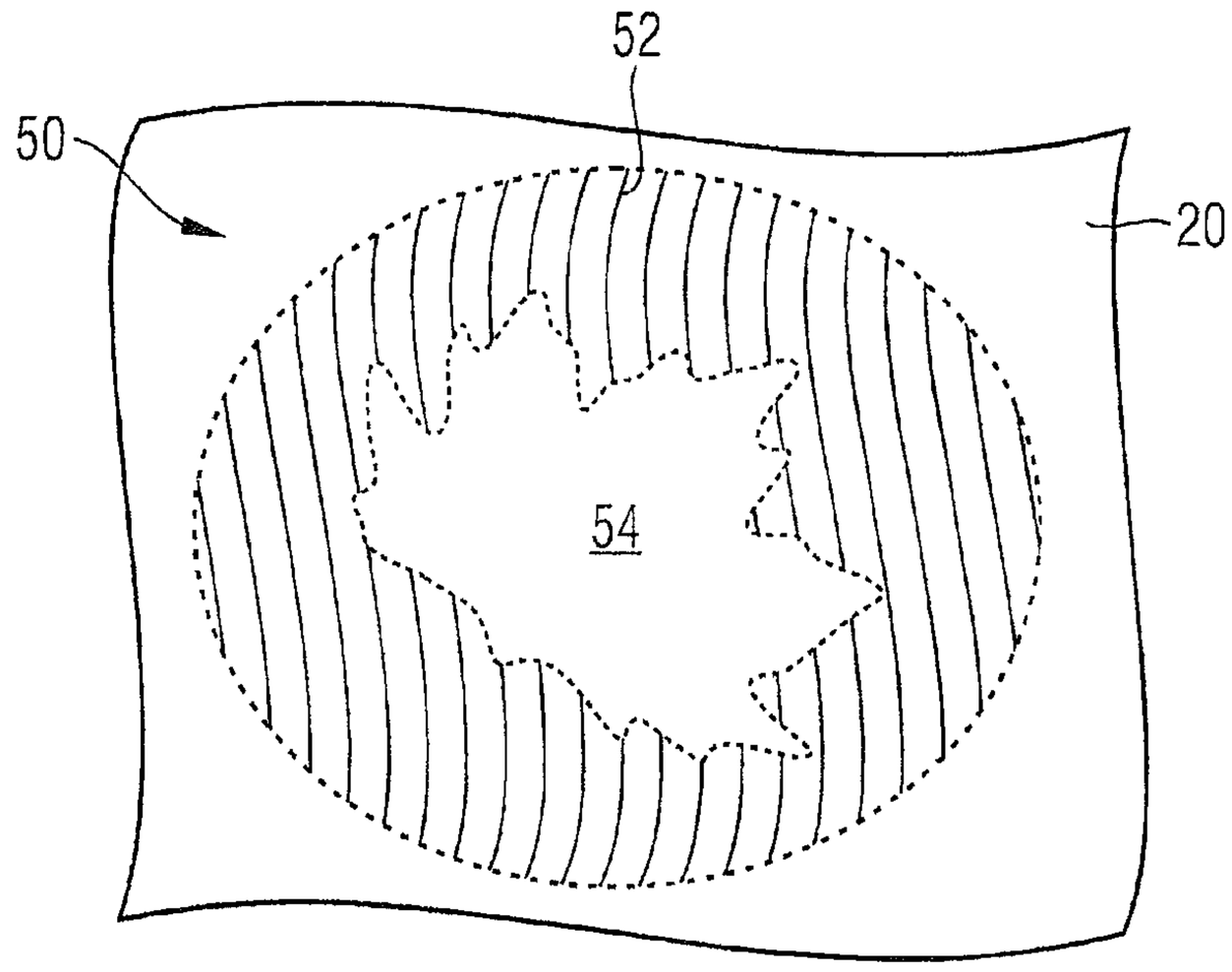

Fig. 4

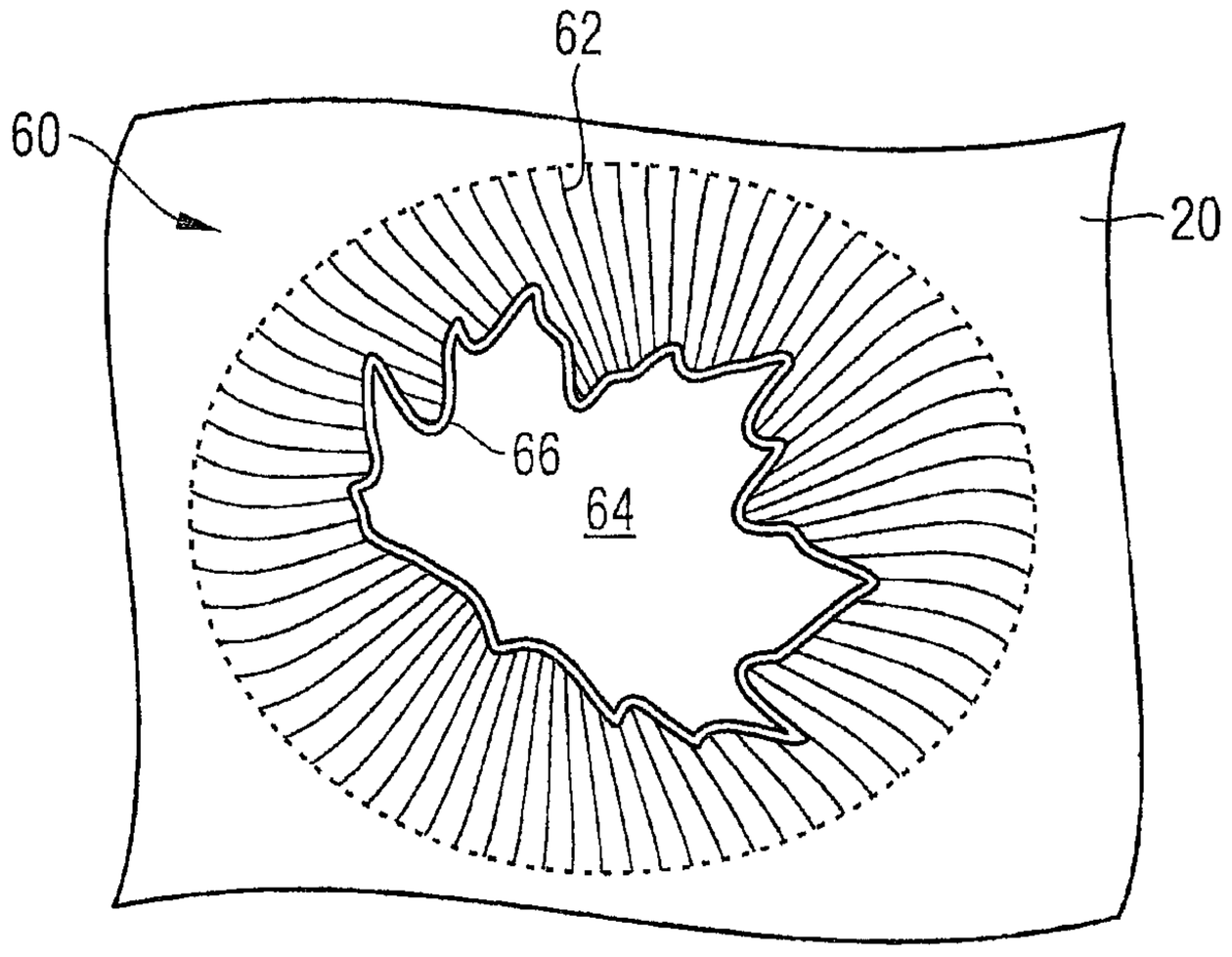

Fig. 5

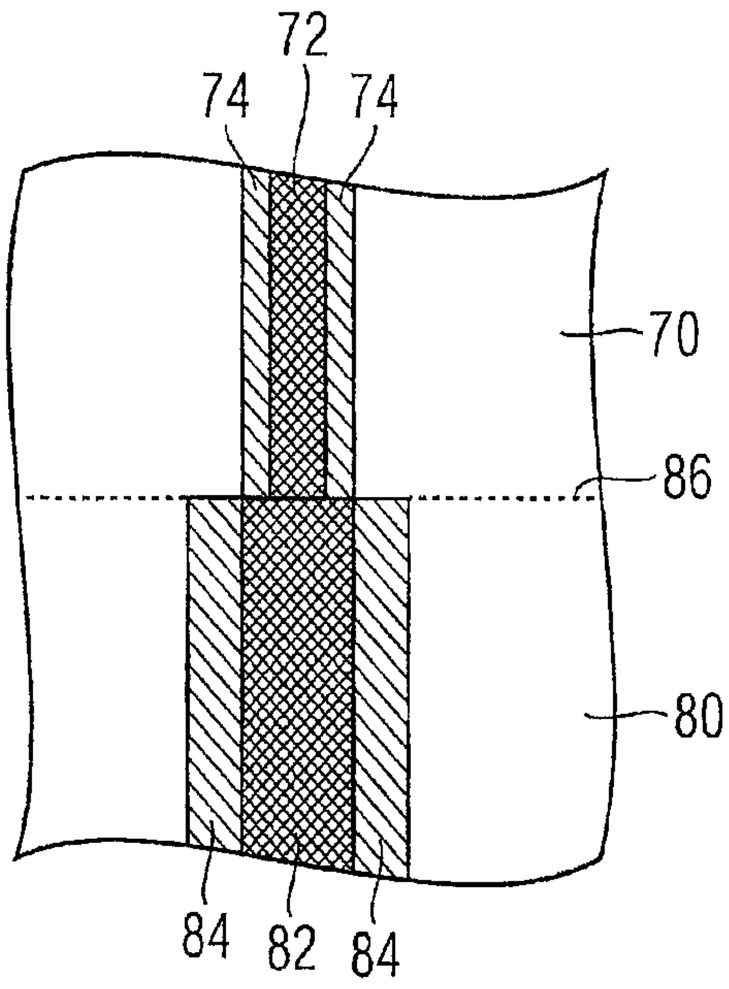

Fig. 6

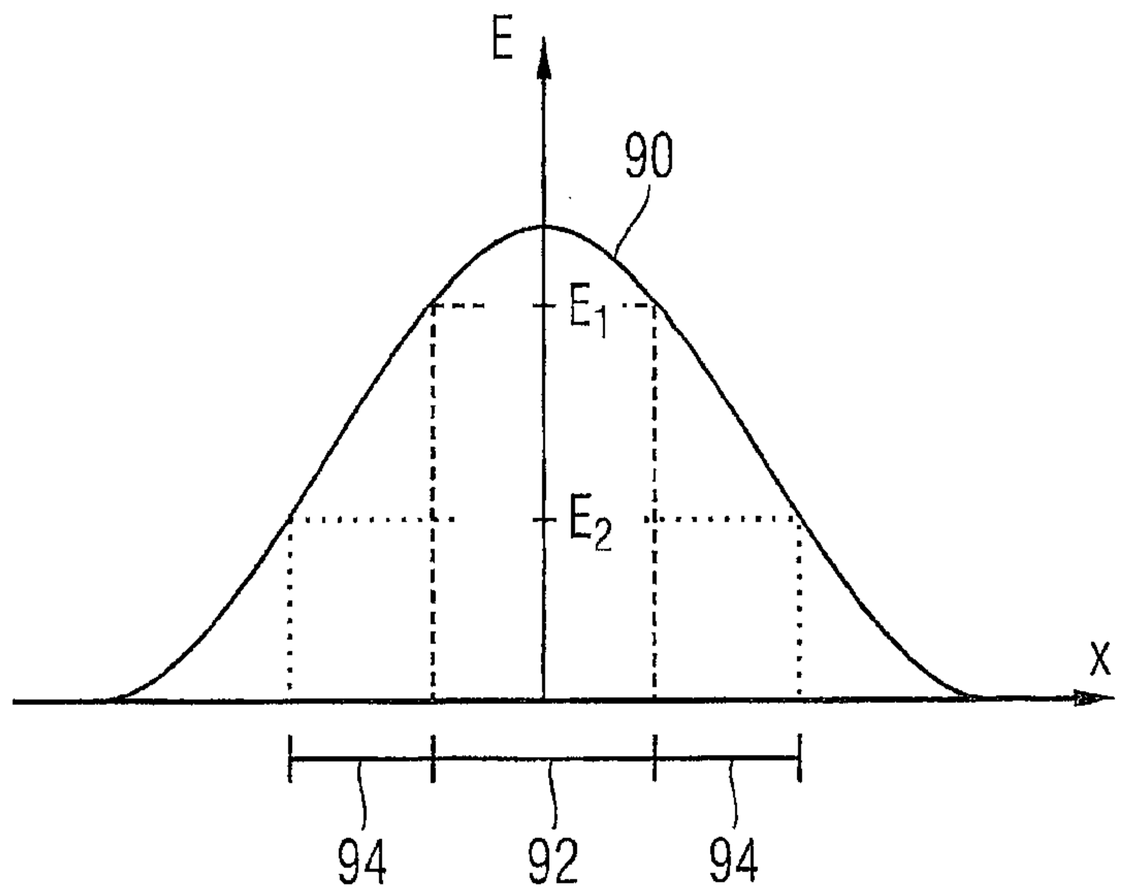

Fig. 7

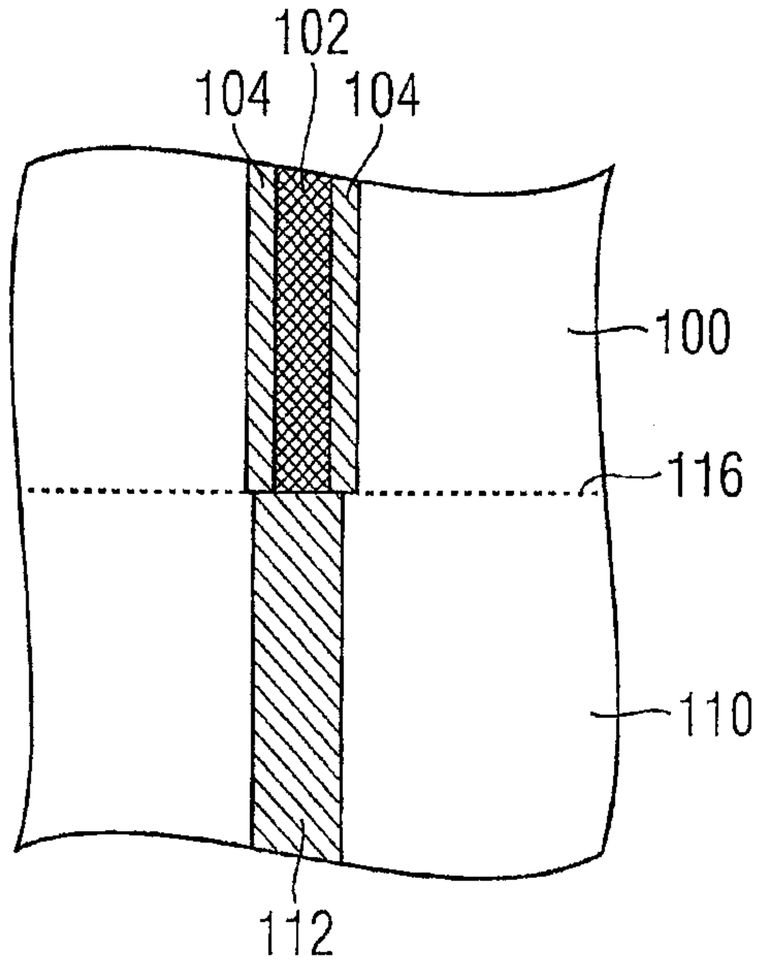

Fig. 8

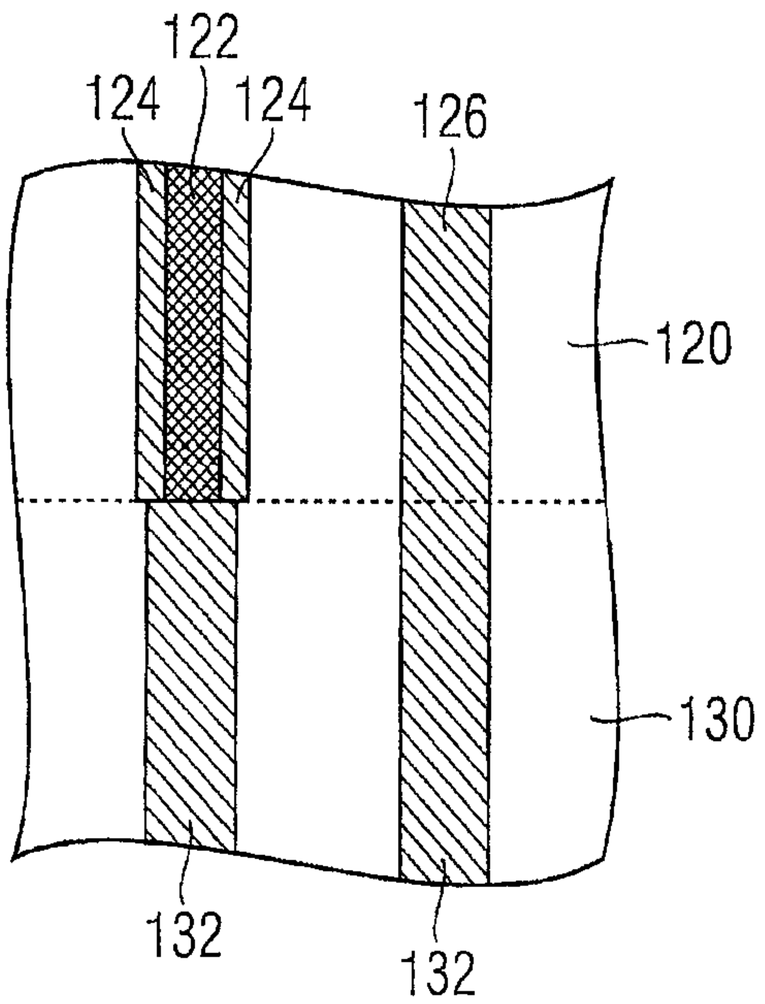

Fig. 9

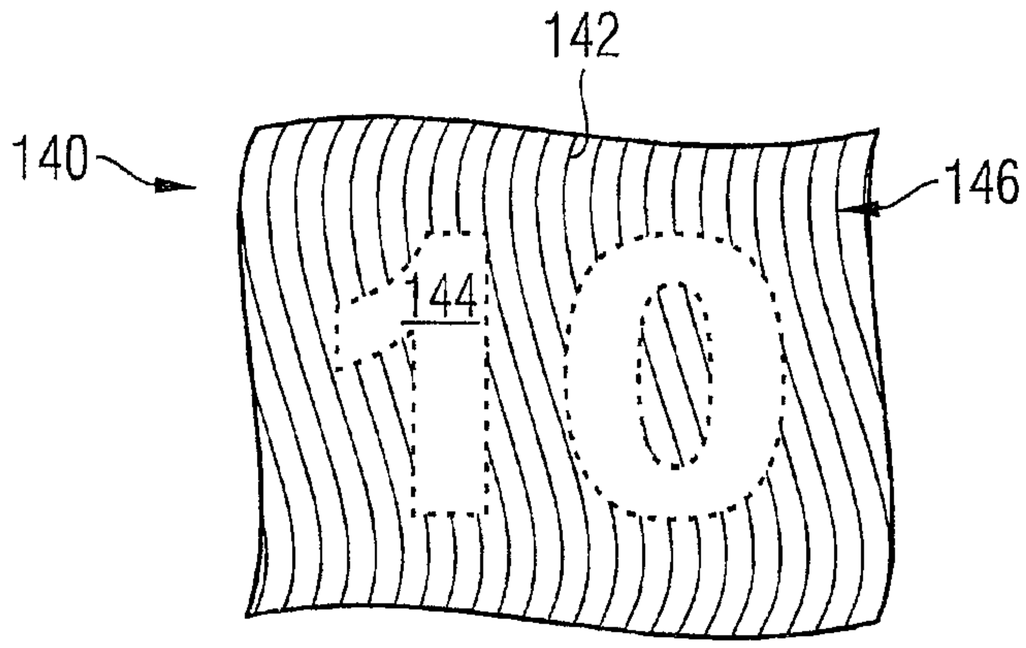

Fig. 10a

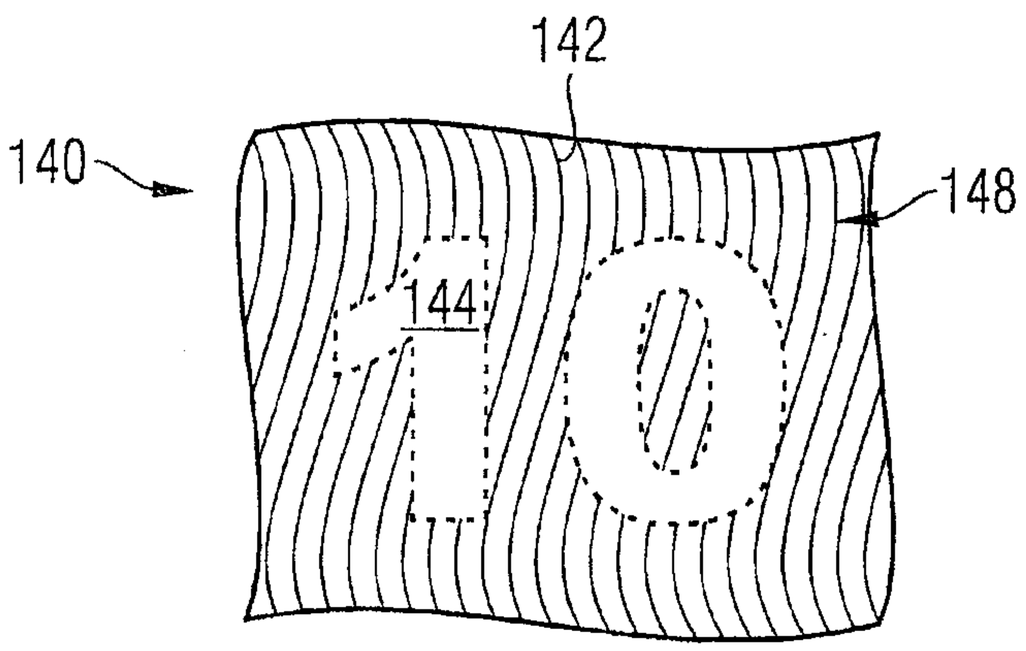

Fig. 10b

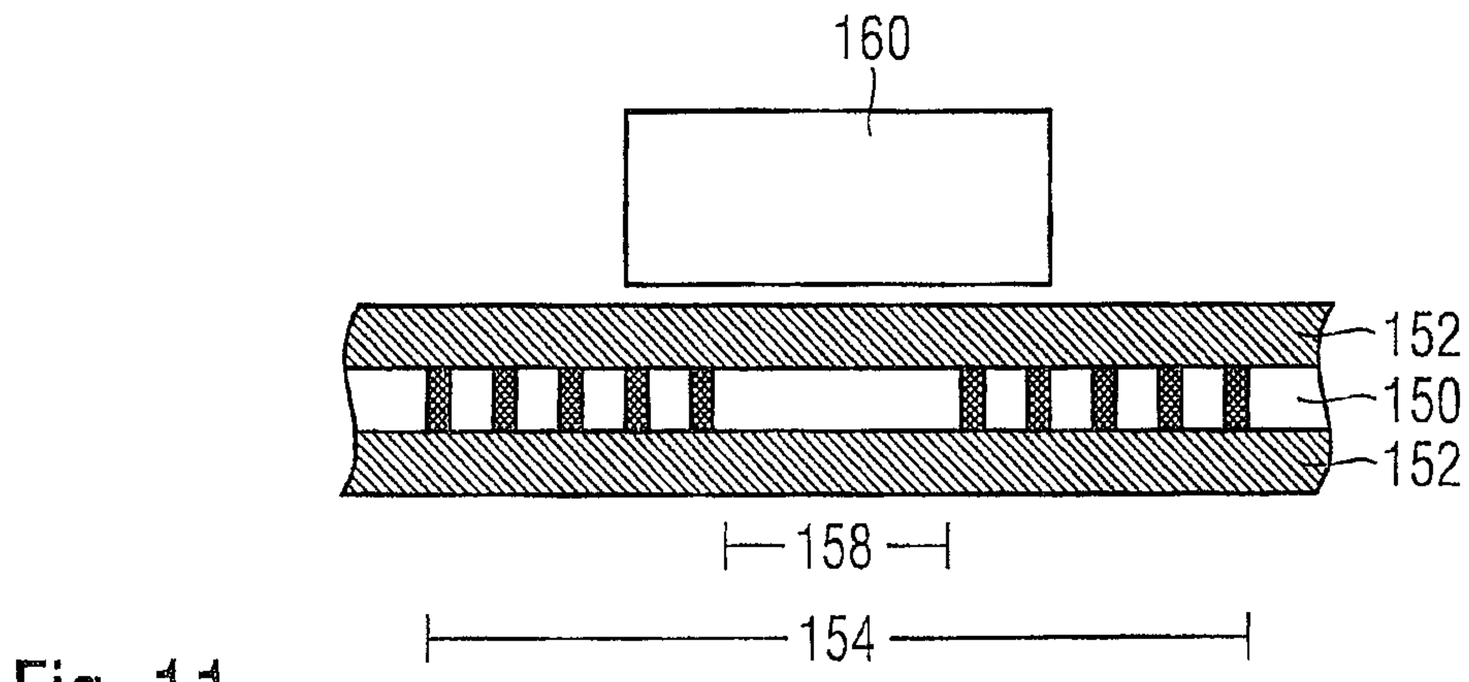

Fig. 11

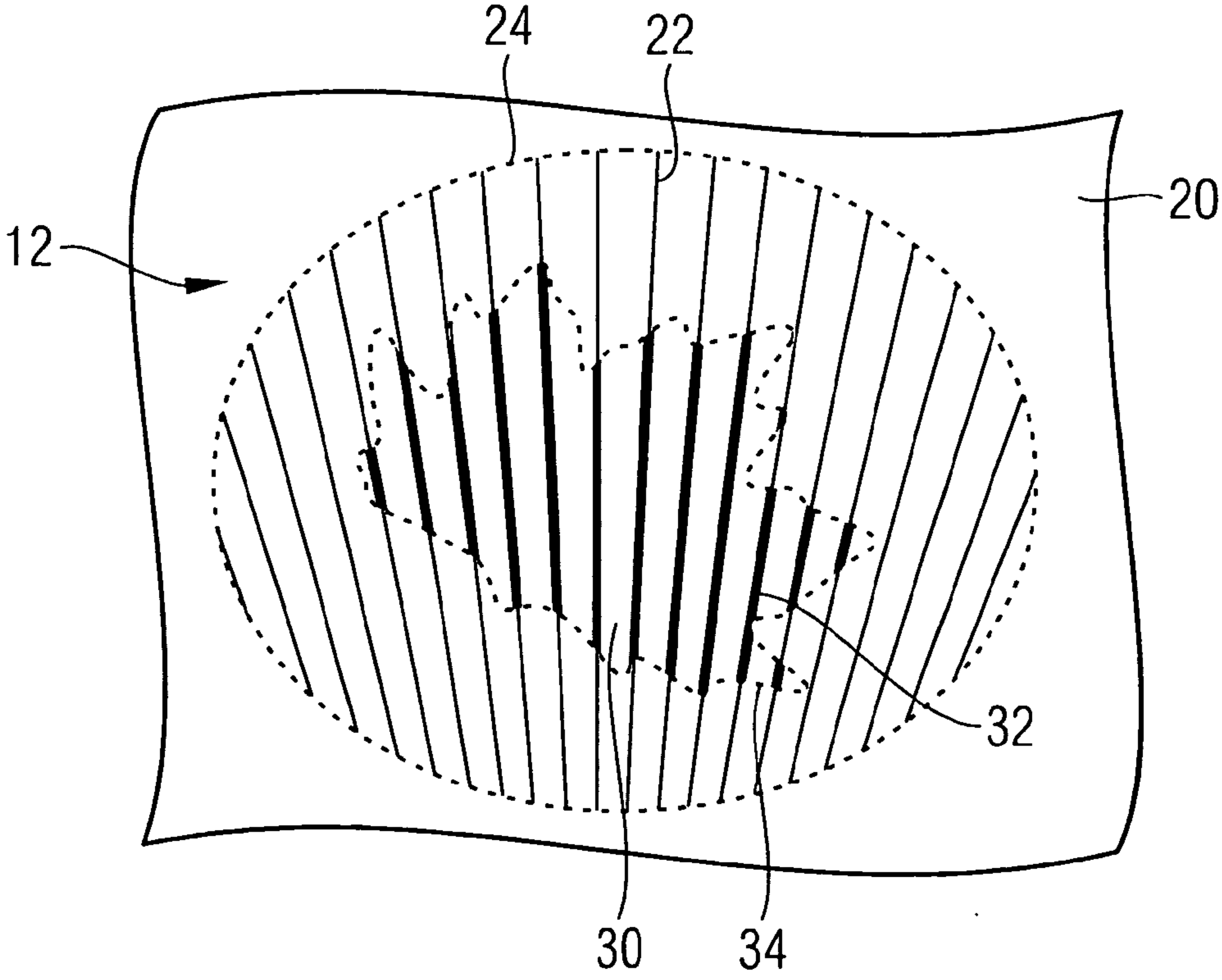

Fig. 2