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Other: **None**

(72) Inventor(s):
Brian William Holmes
Mark Harding

(73) Proprietor(s):
De La Rue International Limited
(Incorporated in the United Kingdom)
De La Rue House, Jays Close, Viables,
BASINGSTOKE, Hampshire, RG22 4BS,
United Kingdom

(74) Agent and/or Address for Service:
Gill Jennings & Every LLP
The Broadgate Tower, 20 Primrose Street, LONDON,
EC2A 2ES, United Kingdom

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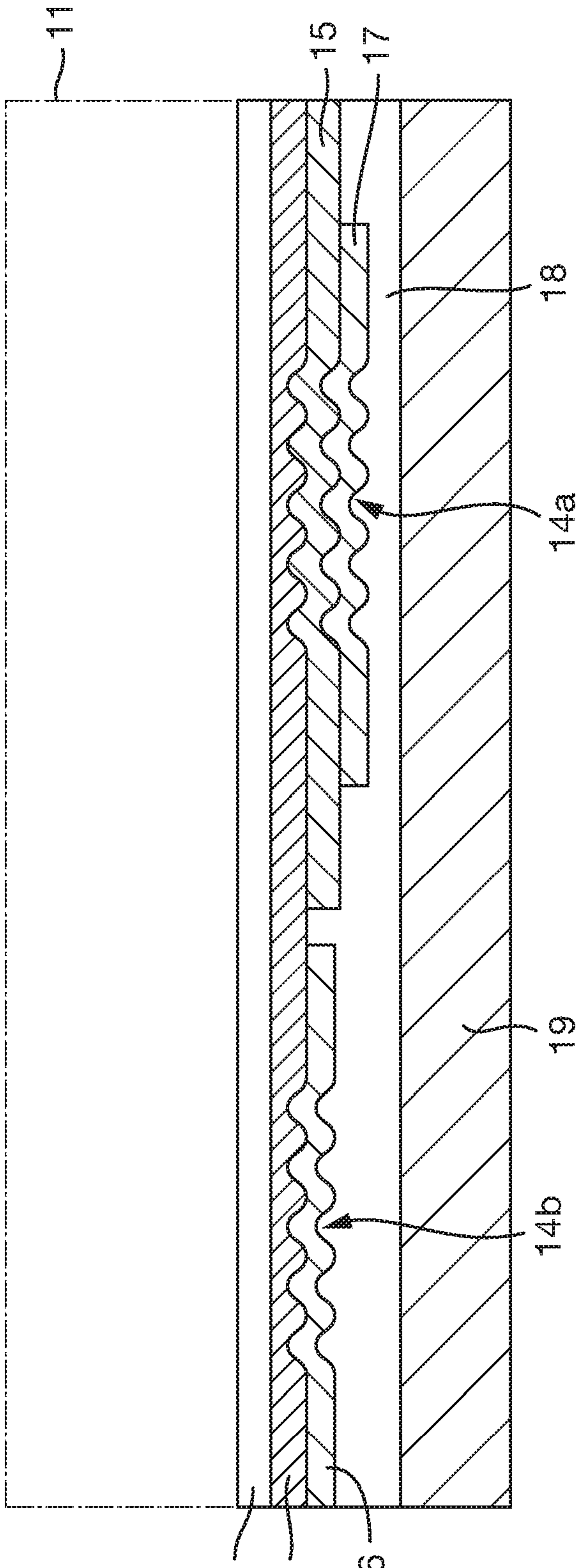


Fig. 1

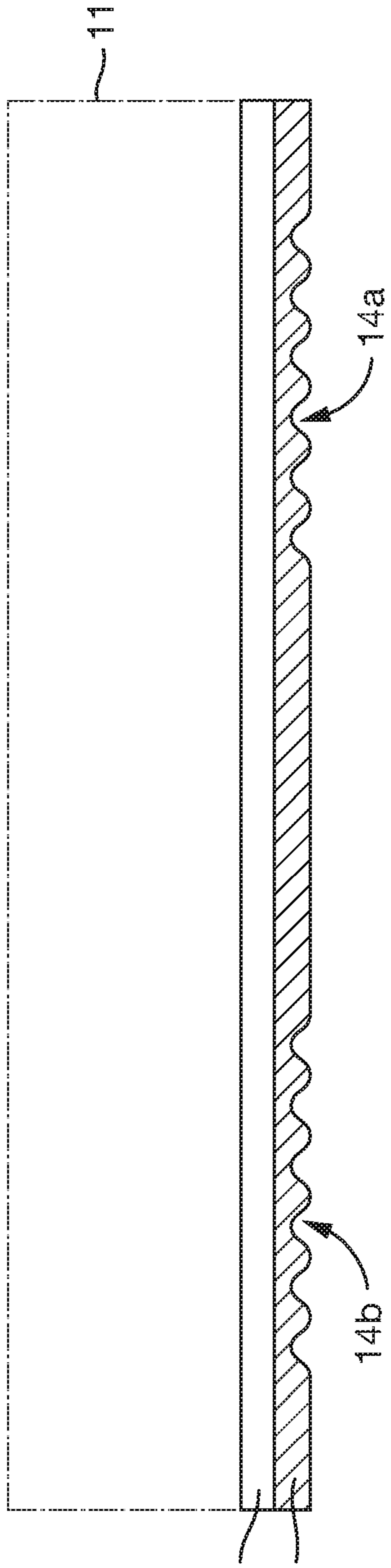


Fig. 2

Fig. 3

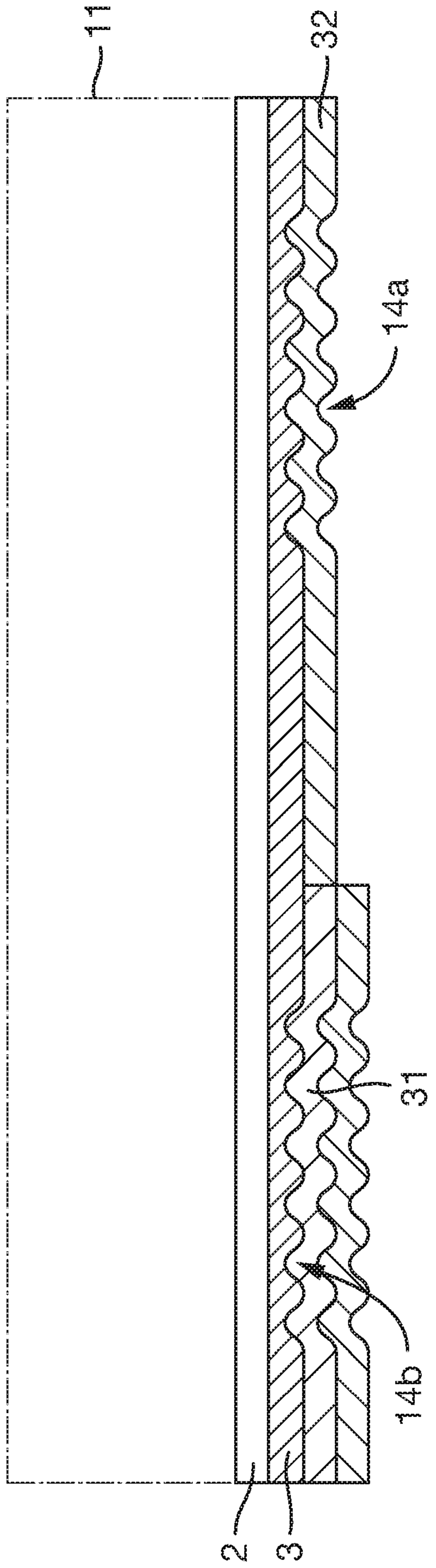
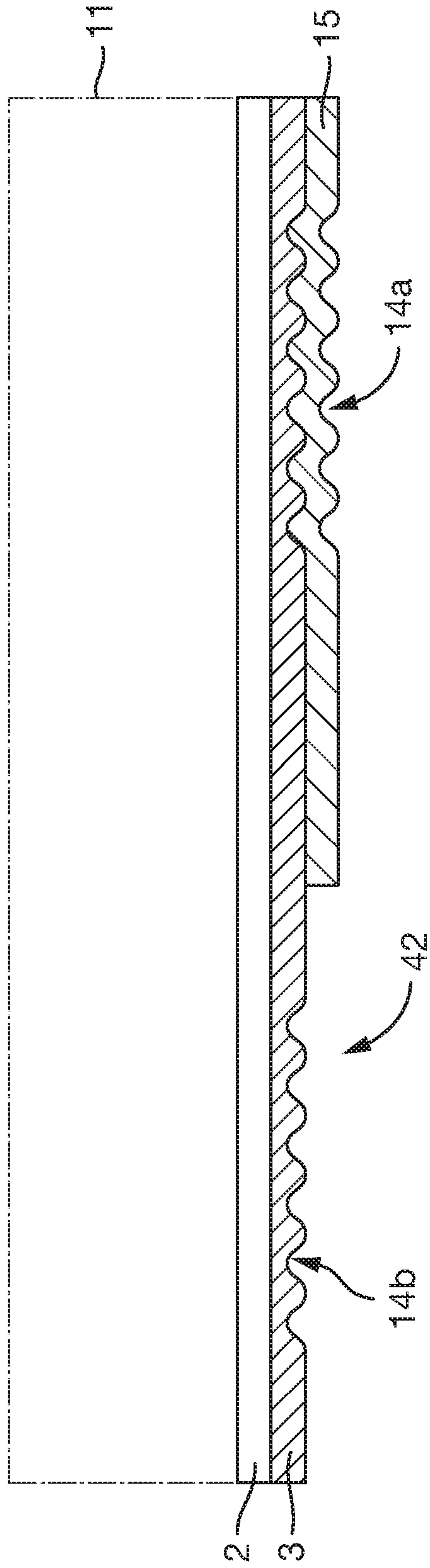


Fig. 4



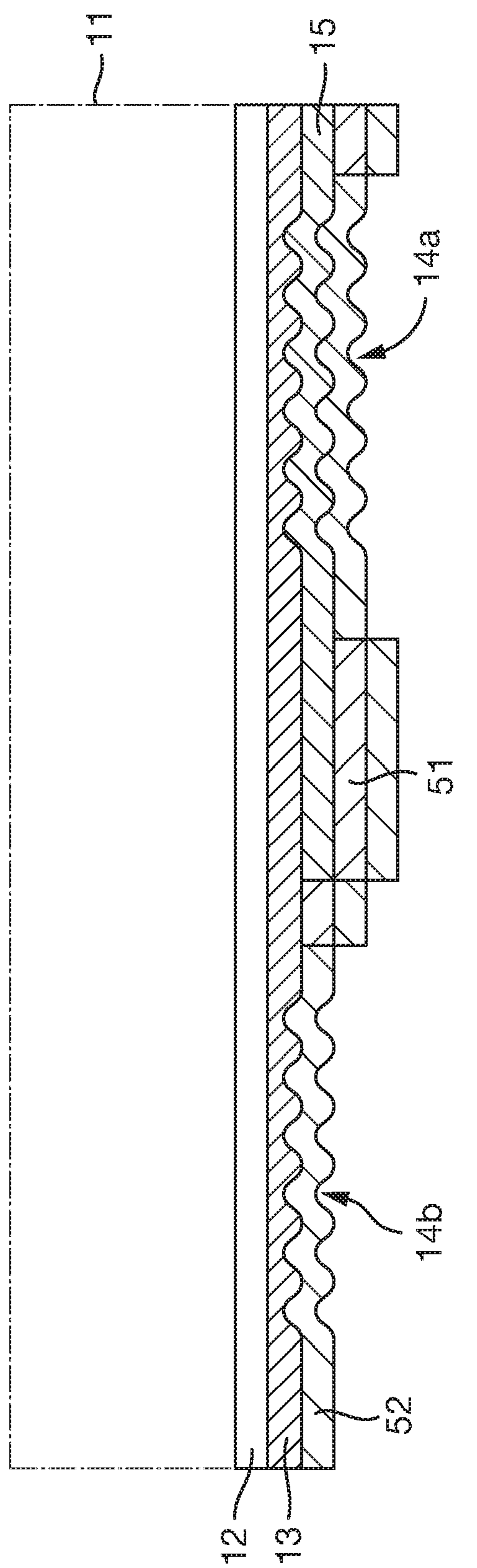


Fig. 5

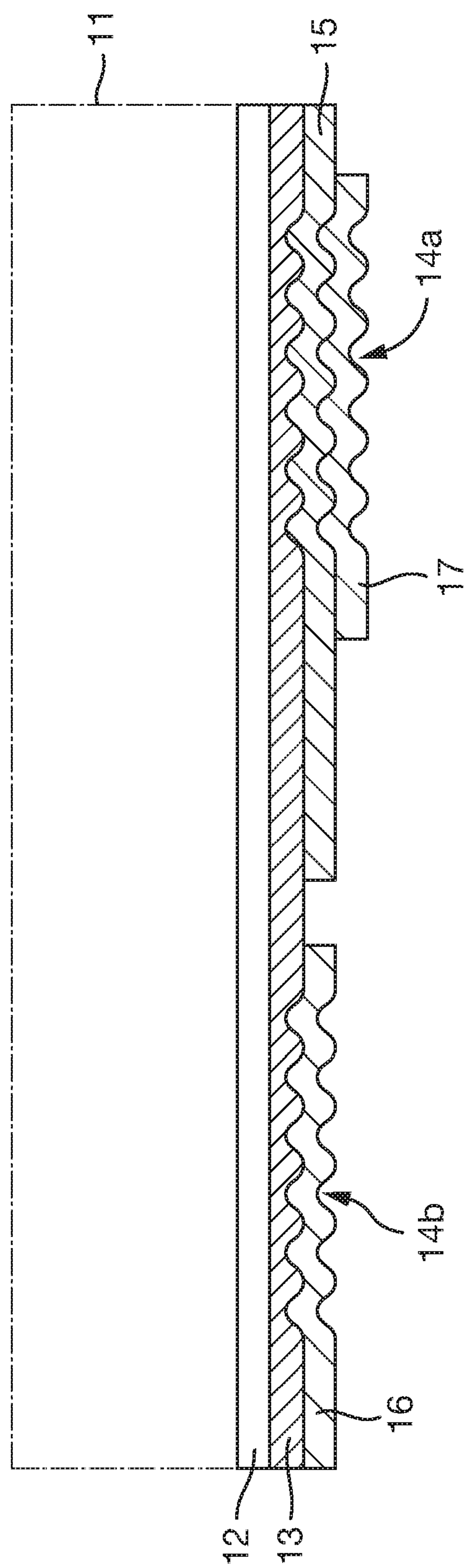


Fig. 6

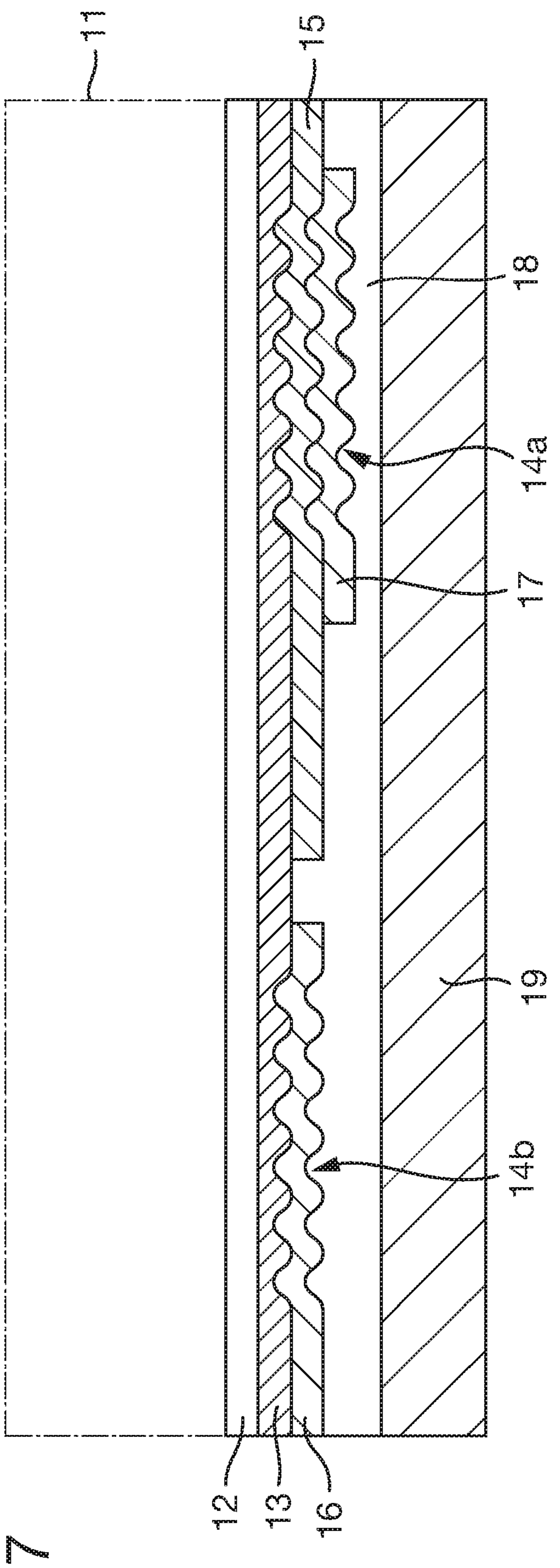


Fig. 7

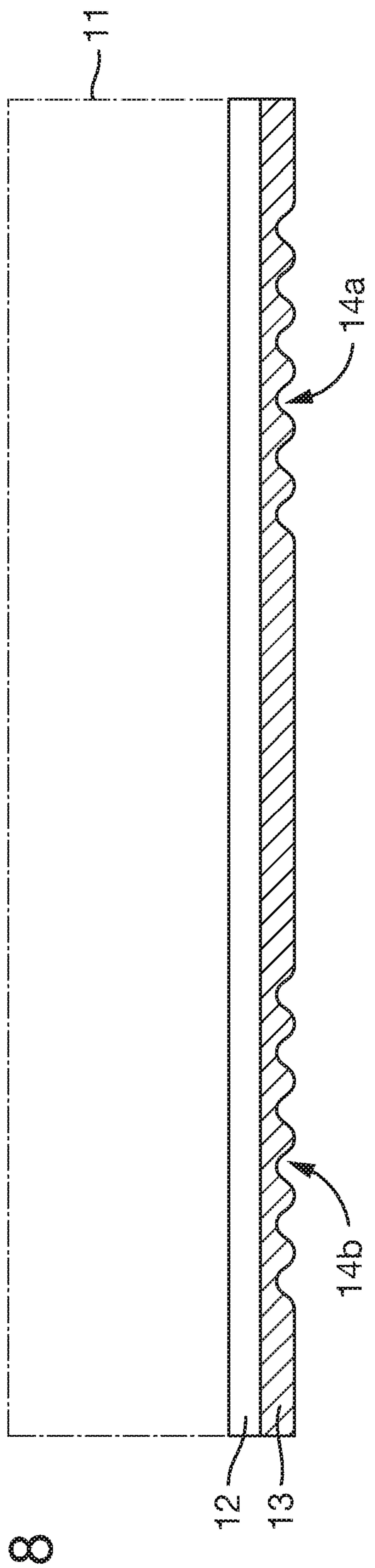


Fig. 8

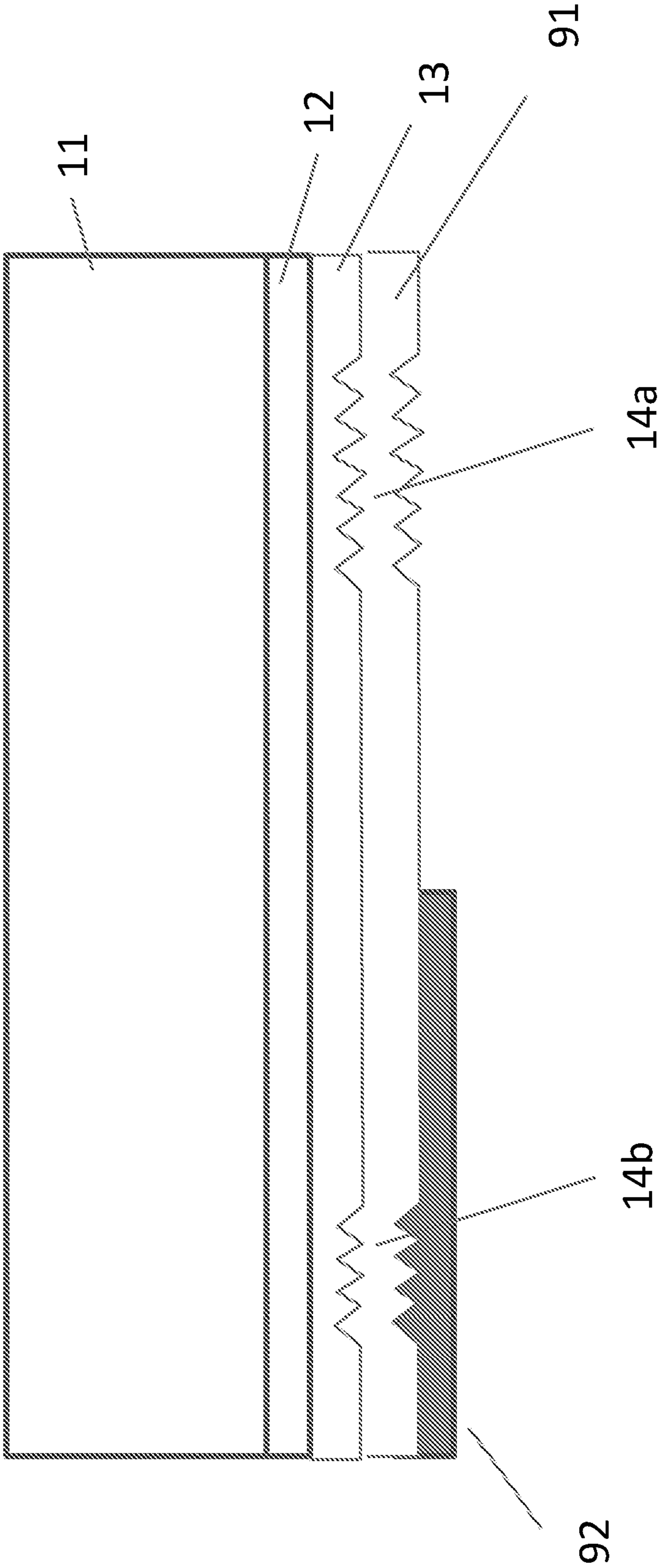


Figure 9

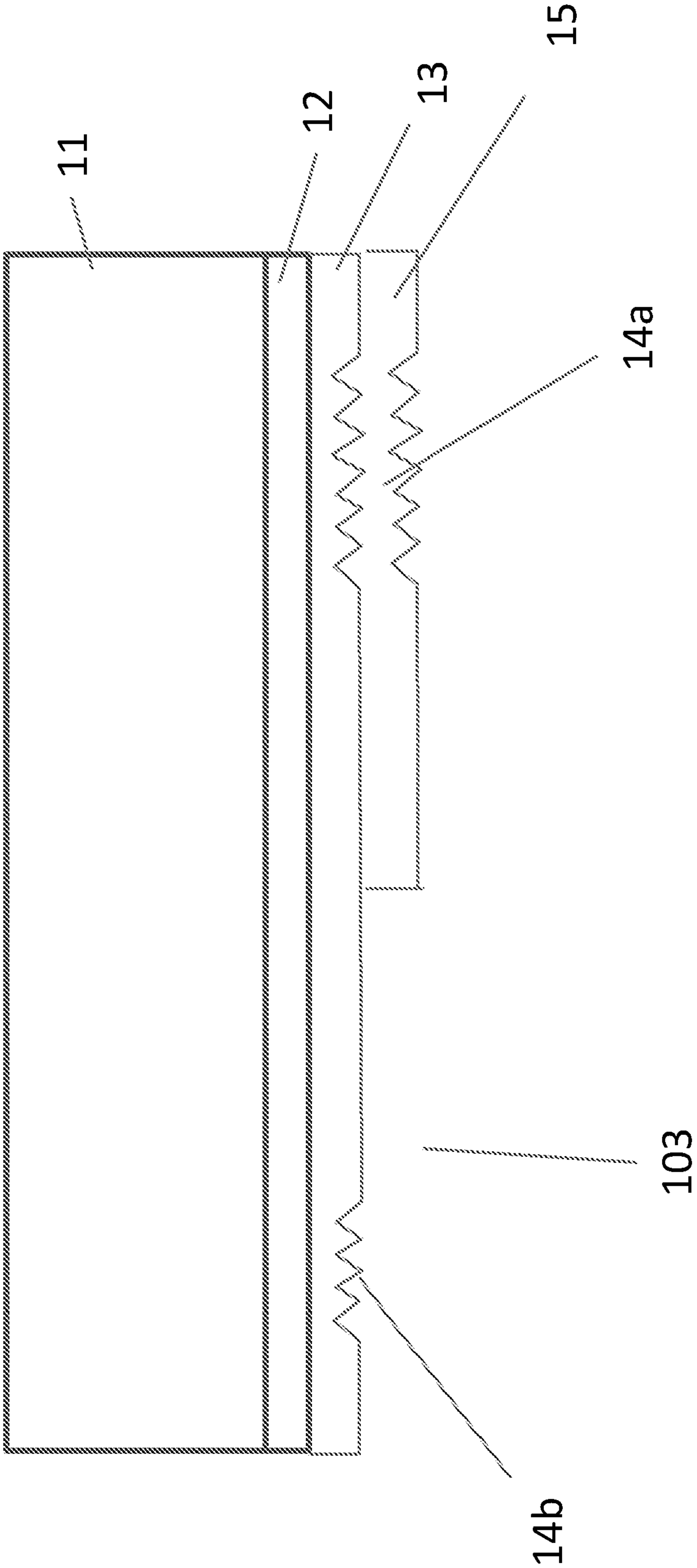


Figure 10

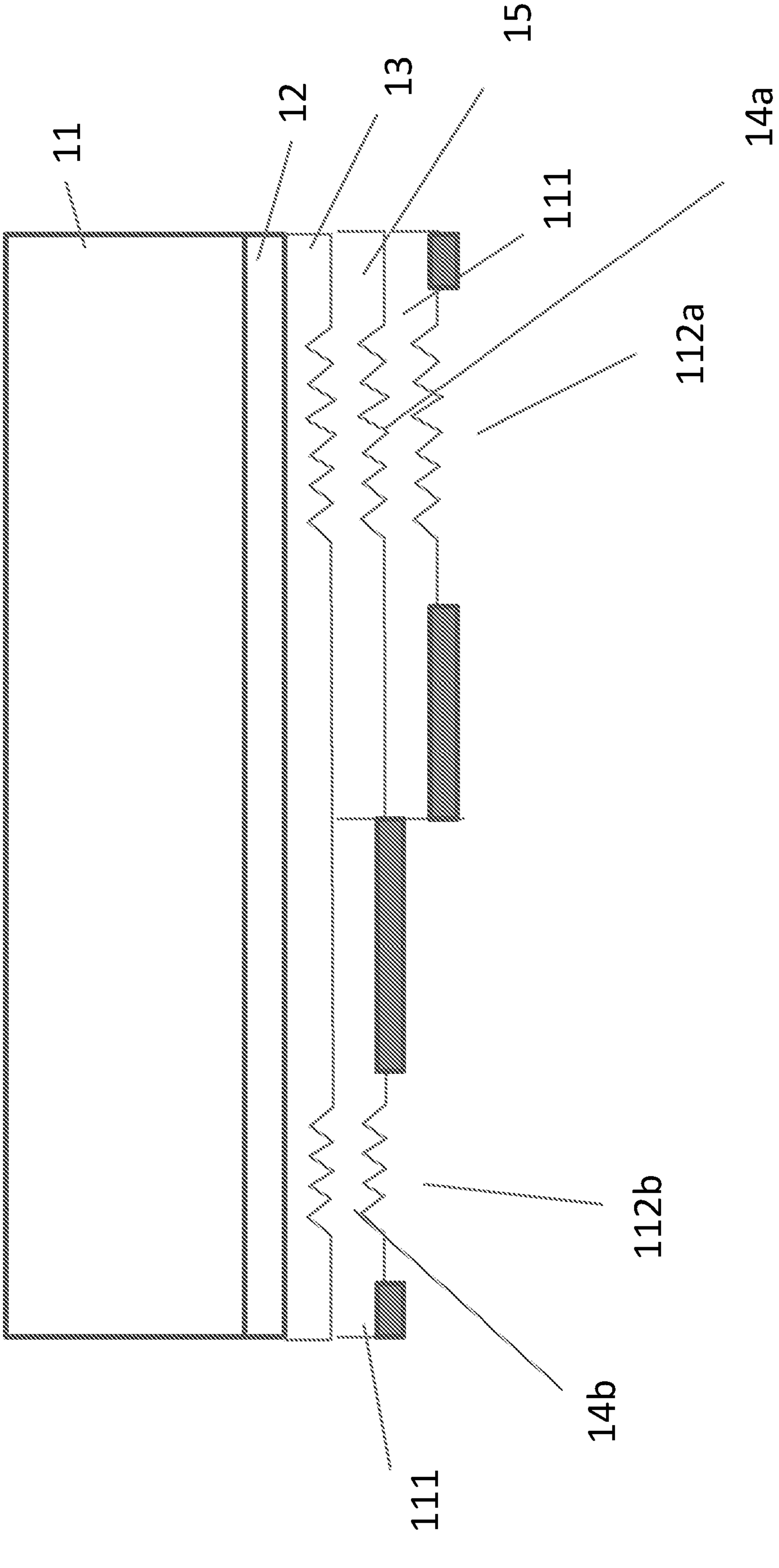


Figure 11

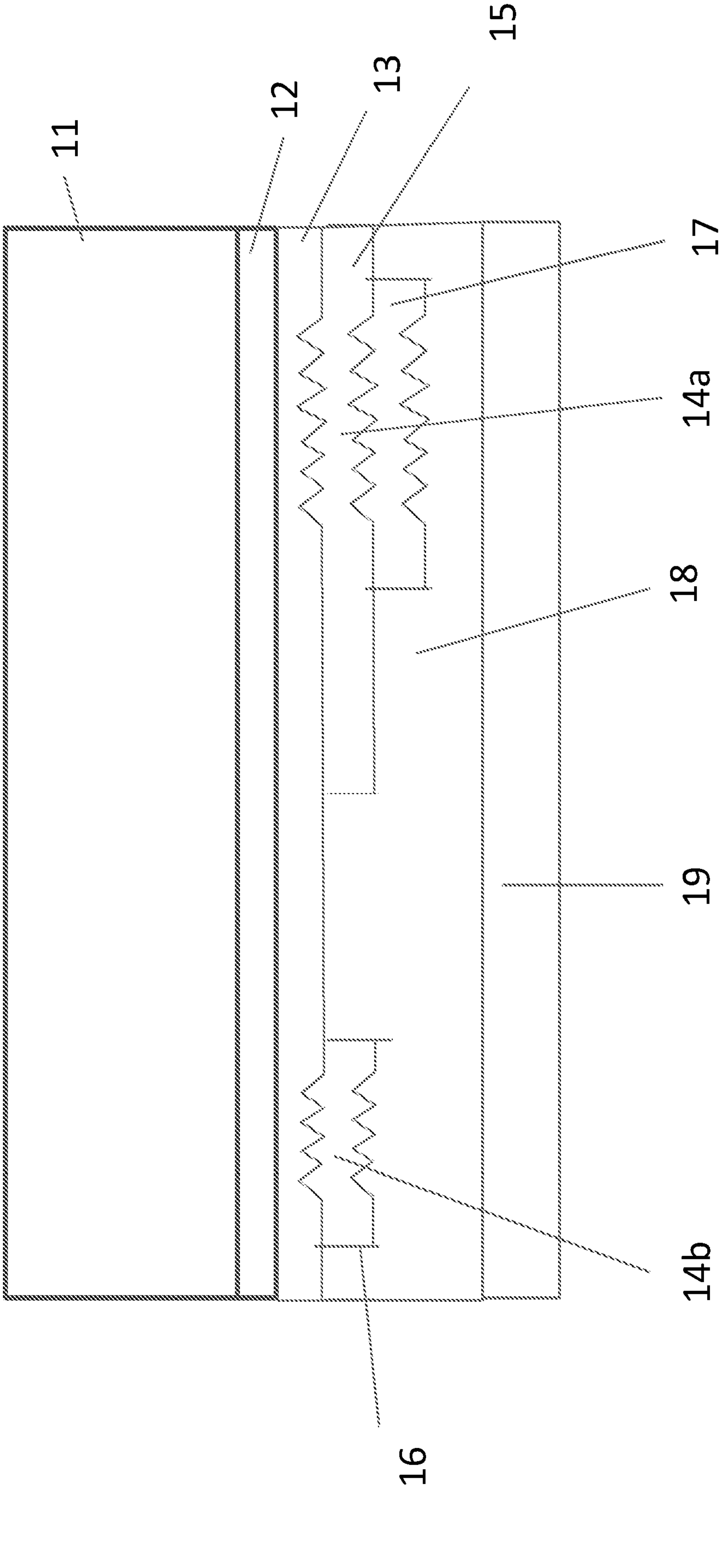


Figure 12

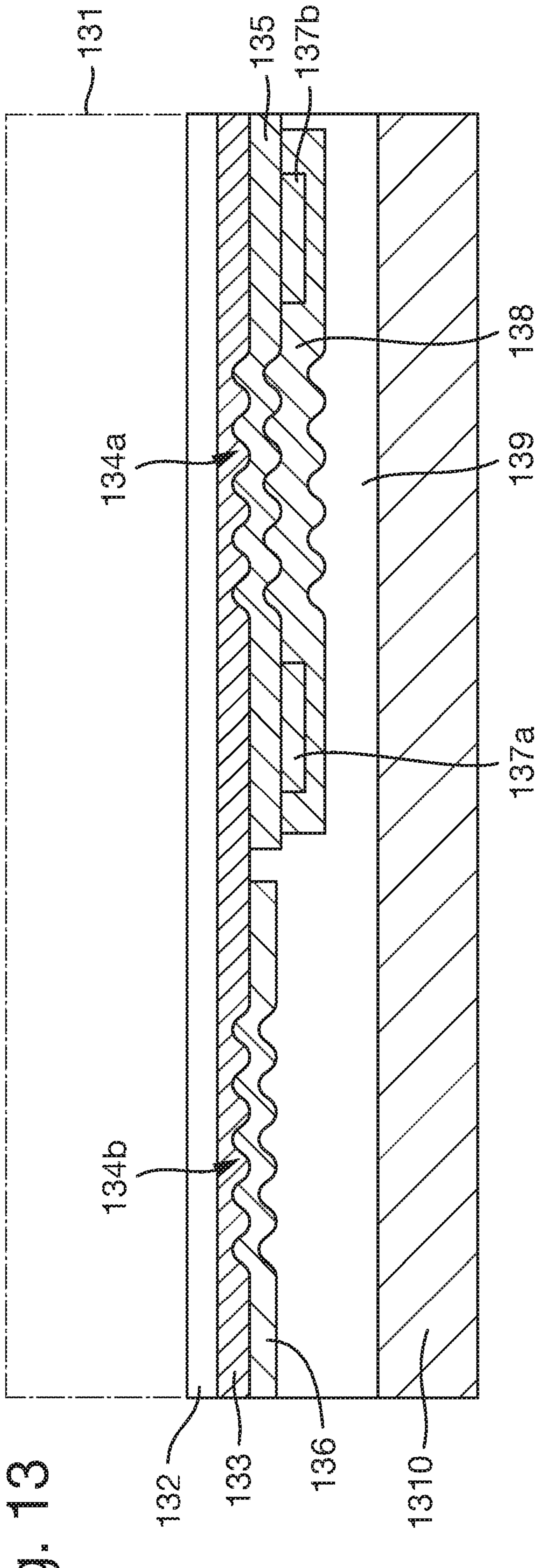

131
135
137b
138
134a
139
137a
134b
132
133
136
1310

Fig. 13

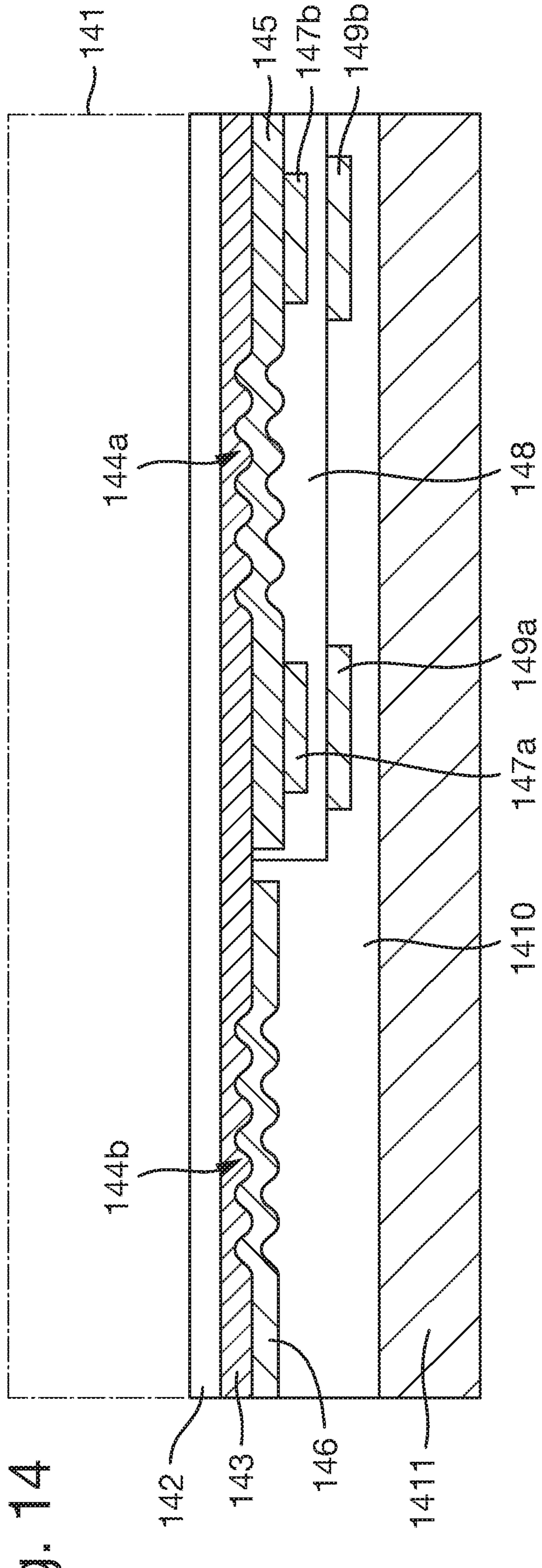

141
145
147b
149b
144a
148
149a
147a
1410
144b
142
143
146
1411

Fig. 14

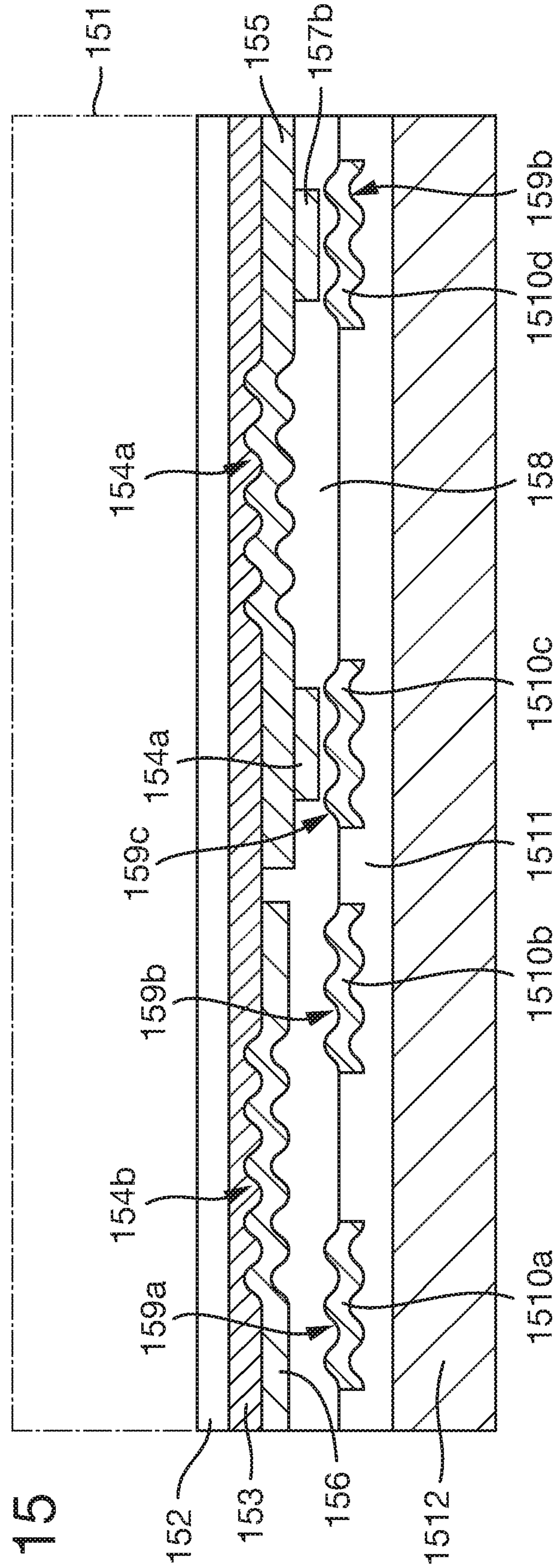

151
155
157b
159b
1510d
154a
158
1510c
154a
159c
1511
159b
1510b
154b
159a
1510a
152
153
156
1512

Fig. 15

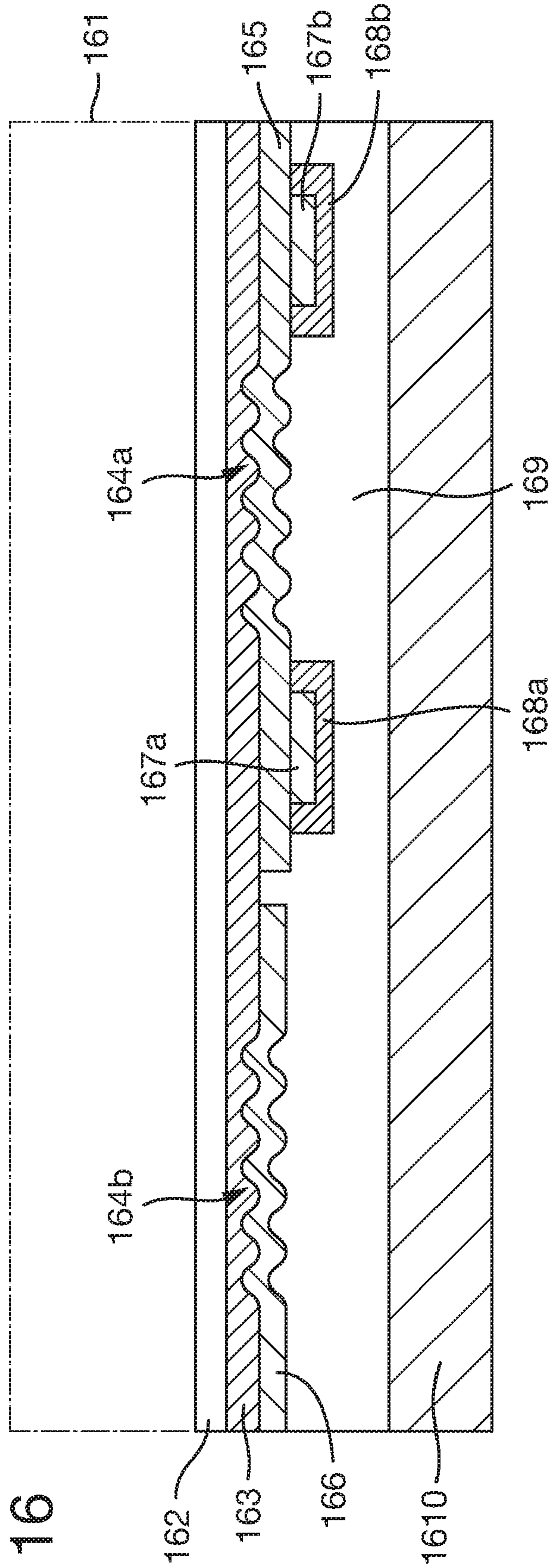

161
165
167b
168b
164a
169
168a
167a
164b
162
163
166
1610

Fig. 16

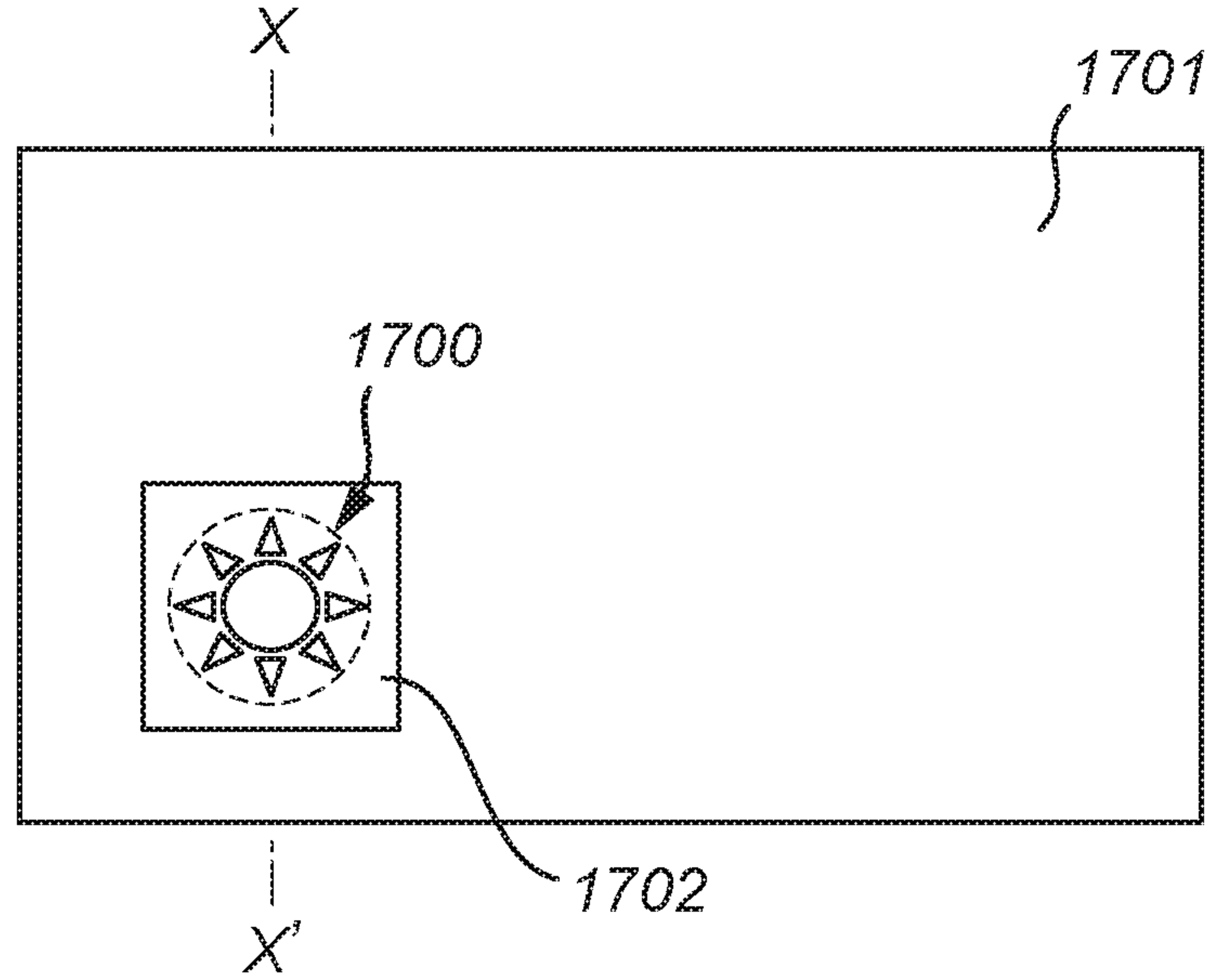


FIG. 17a

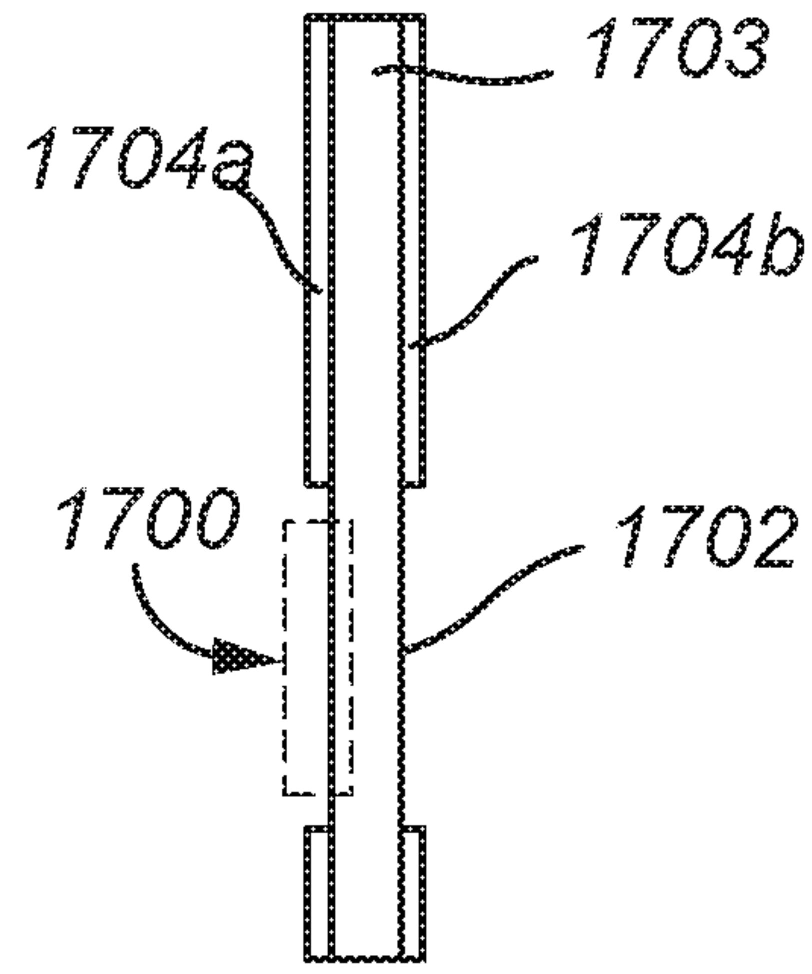


FIG. 17b

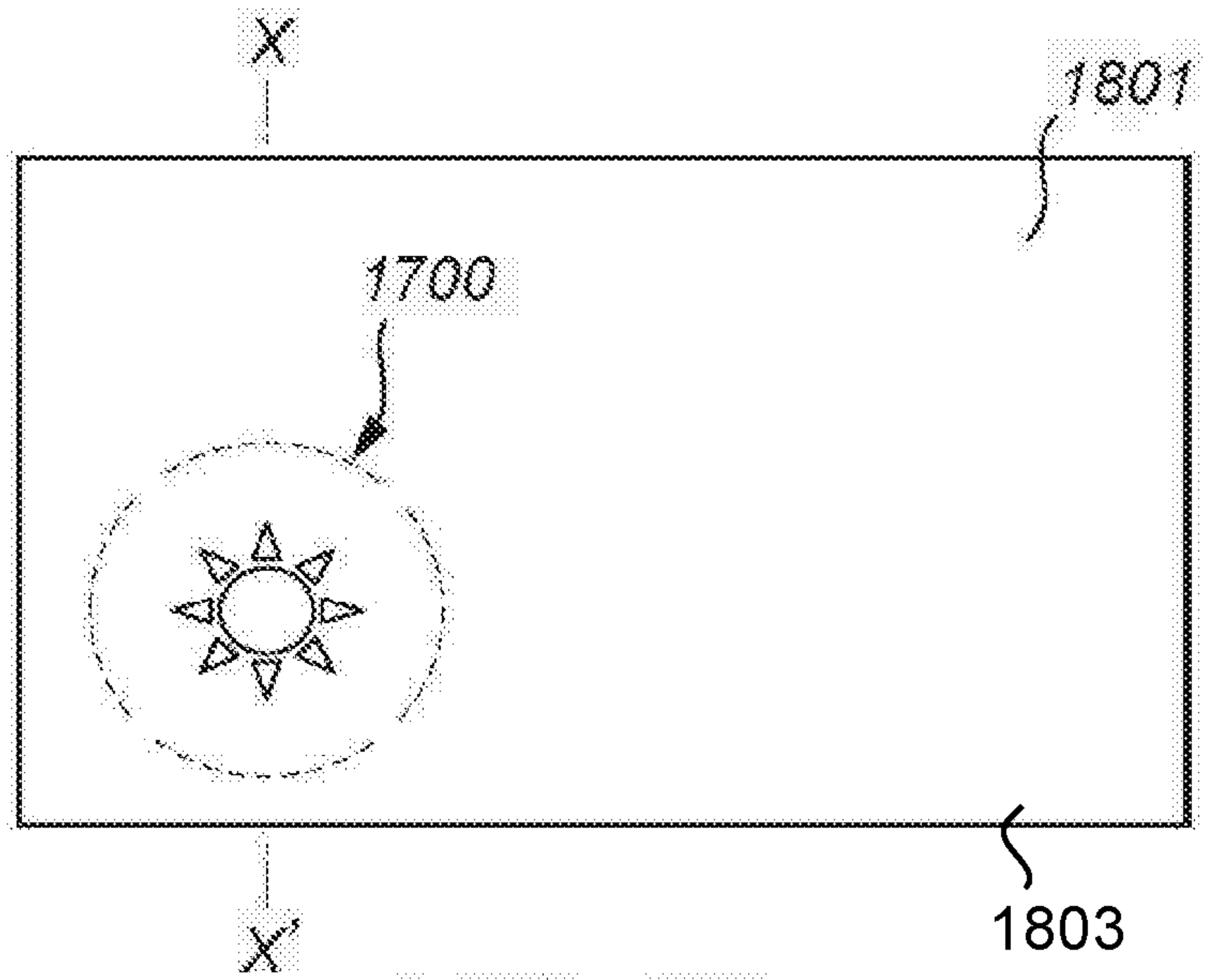


FIG. 18

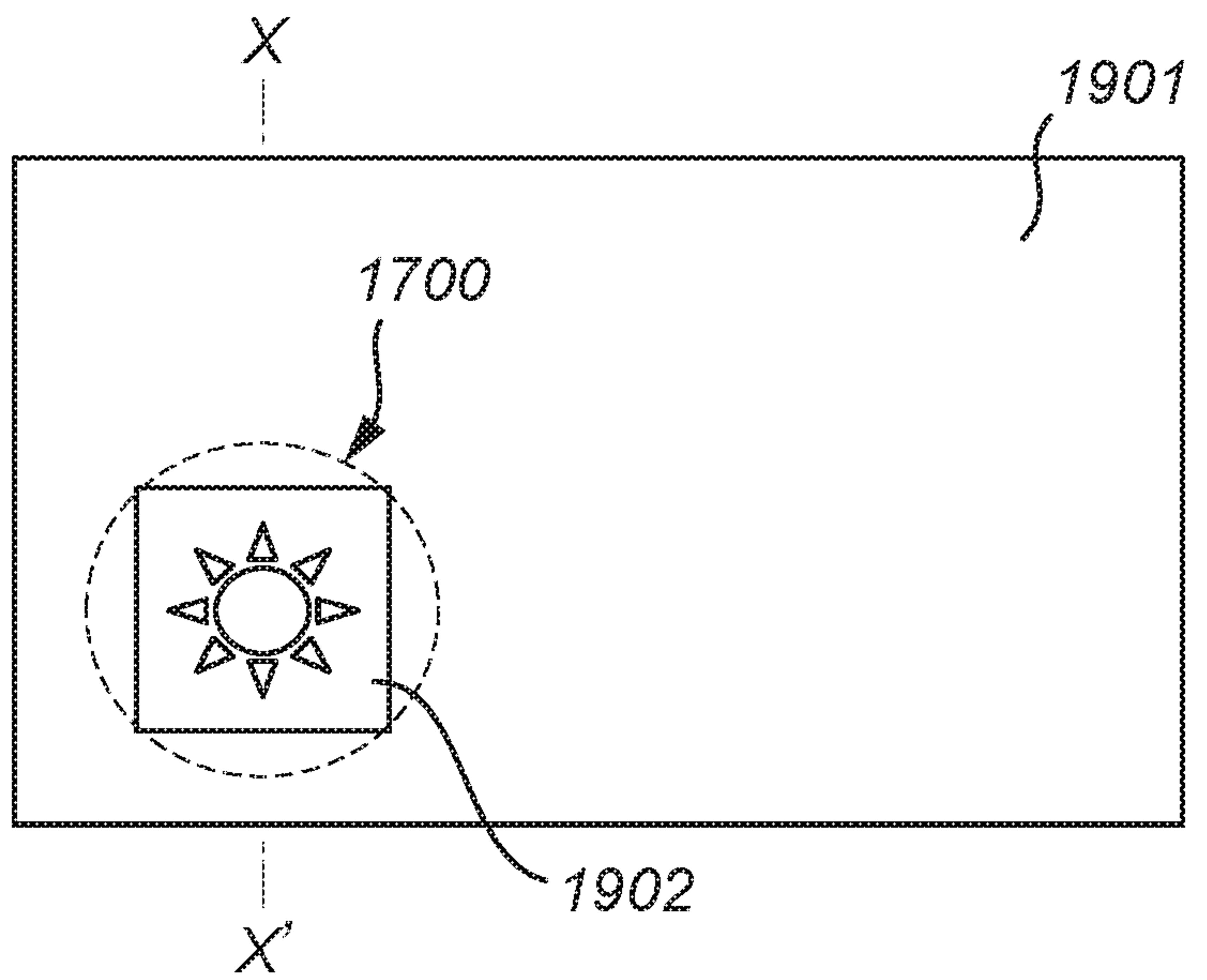


FIG. 19a

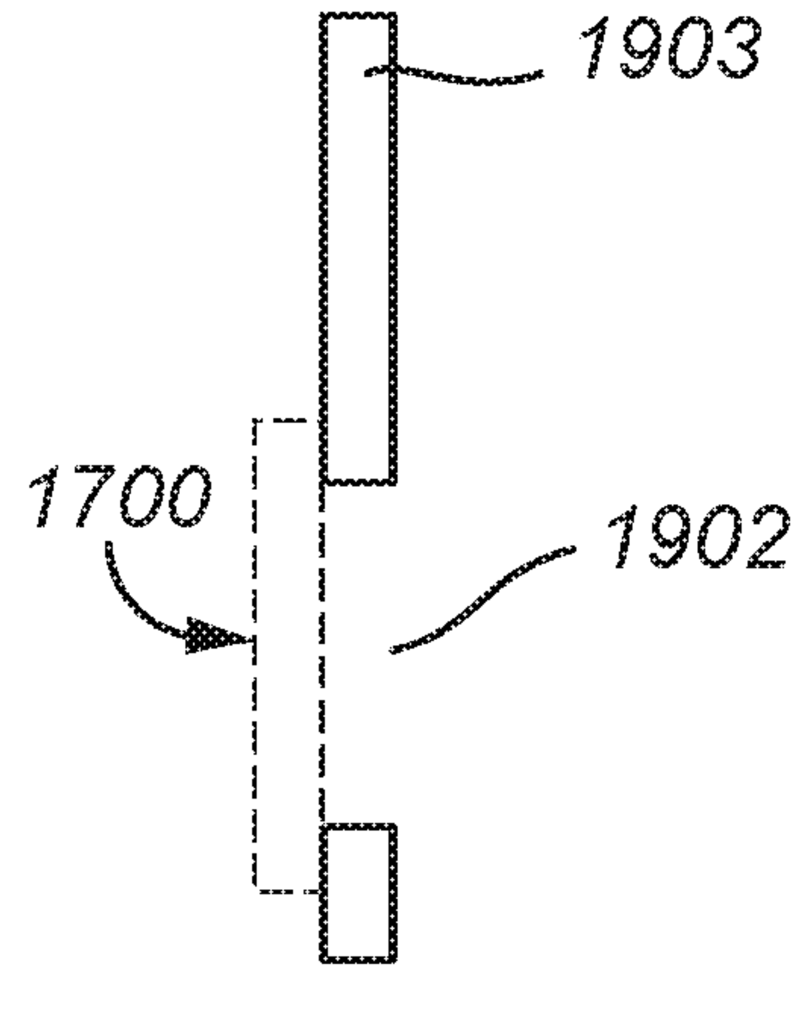


FIG. 19b

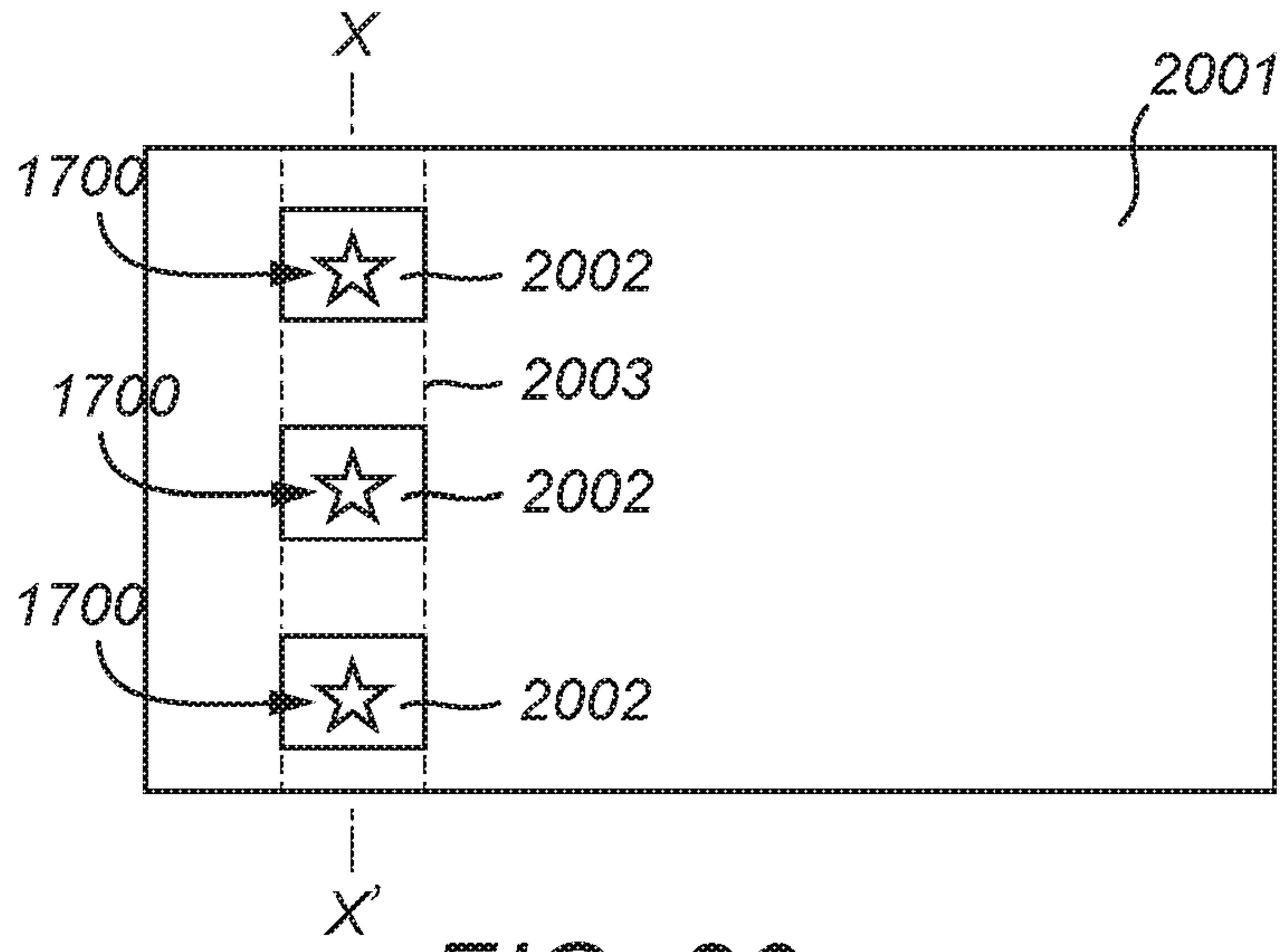


FIG. 20a

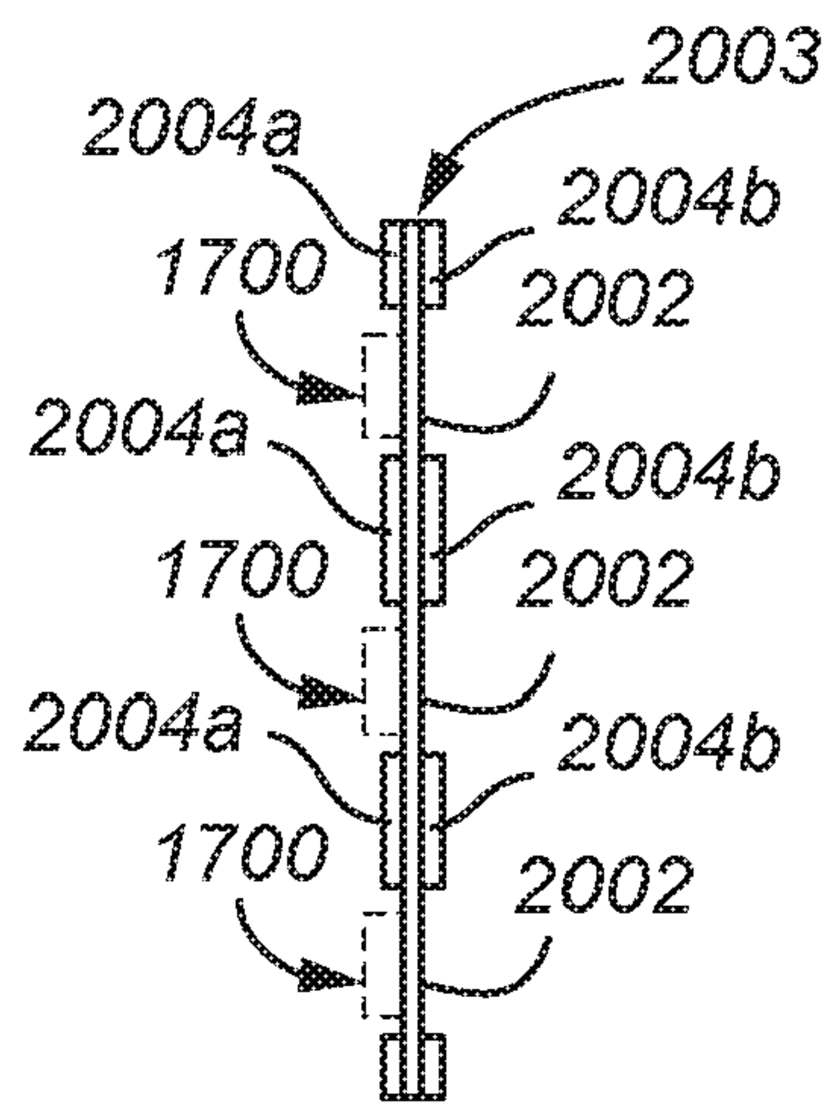


FIG. 20b

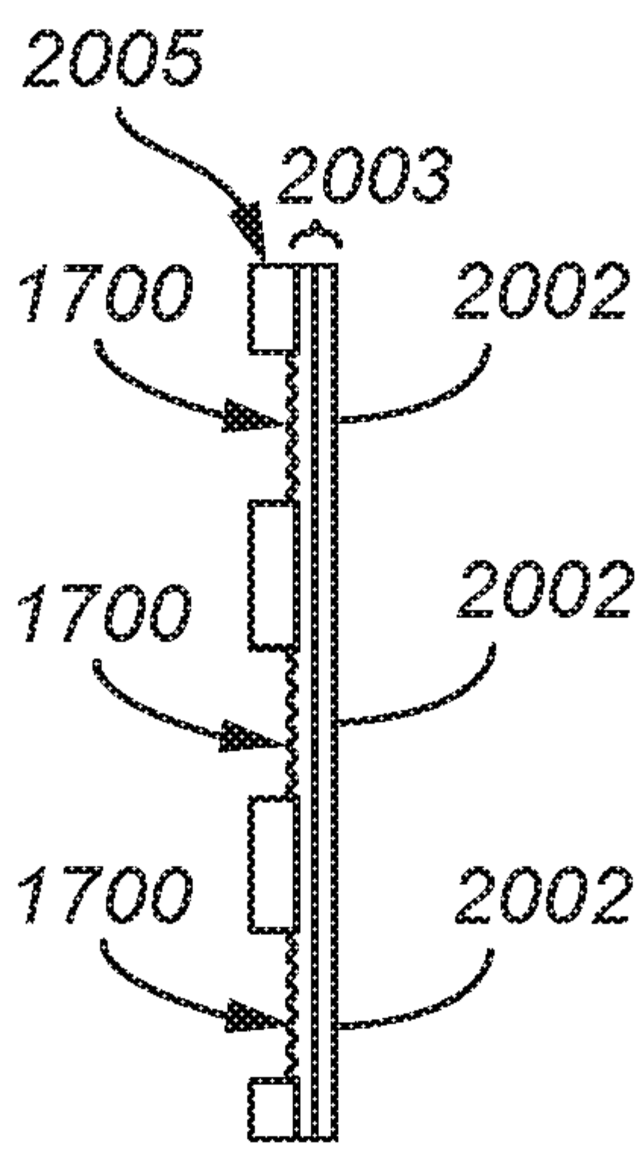


FIG. 20c

Security Device and Method

Field of the Invention

This invention relates to security devices, suitable for establishing the authenticity of objects of value, particularly security documents, and their methods of manufacture. In particular, the invention relates to security devices incorporating optically variable effect generating relief structures such as holograms and diffraction gratings.

Background of the Invention

Such security devices often make use of reflection enhancing materials provided behind the holograms or diffraction gratings. Examples of these are in bimetallic, or bichrome, security devices. In such devices at least two different reflection enhancing materials, typically metals, are used to vary the background of the optical effect of the holograms or diffraction gratings, such that the said optical effect is spatially modulated. An example of such a security device is described in WO 02/00446 A1.

Security devices making use of more than one reflection enhancing material often suffer, however, from galvanic corrosion of the reflection enhancing materials. When the two materials are in contact a galvanic potential is formed, leading to preferential corrosion of material with the more negative standard electrode potential. However, if the two materials are not in contact then the material with the higher electrode potential is not protected from direct acid attack.

Although in the past sacrificial anodes have been used to protect reflection enhancing materials, see for example EP 2 524 814 A2, this has been when there is only one reflection enhancing material in a security device. Therefore, what is needed is a solution to the problems of galvanic corrosion of, and acid attack on, visible elements of security devices with more than one reflection enhancing material. Acid attack comes from substances such as acetic acid, which is a common substance in households and in many domestic products. The presence of two metals with different electrode potentials and an acid results in a formation of a galvanic cell where there is transfer of electrons from the metal with the more negative electrode potential (typically aluminium) to the metal with the less negative electrode potential (typically copper). This has two benefits; firstly the transfer of electrons from the aluminium to the copper neutralises the hydronium ions in the acid and therefore reduces the acid attack on the copper, at the same time the transfer of the electrons to the copper stops the formation of Cu ions and therefore reduces the tendency for the copper to oxidise. It is very difficult to make organic layers completely non-permeable and therefore alternative solutions such as this must be sought.

Summary of the Invention

In accordance with the present invention, there is provided a security device comprising: a first metallic region composed of a first metal; a second metallic region composed of a second metal laterally spaced from the first metallic region, the second metal having a more negative standard electrode potential than the first metal, and wherein the first and second metallic regions are not in contact; and at least one sacrificial anode in electrical contact with the metal of the first metallic region but not in electrical contact with the metal of the second metallic region, the at least one sacrificial anode being composed of the second metal.

The present invention solves both the problem of galvanic corrosion of the second metal and the problem of direct acid attack on the first metal. By separating the two metals a galvanic potential is not formed and the second metal does not, therefore, preferentially corrode over the first metal. However, the introduction of a sacrificial anode in electrical contact with the metal of the first metallic region ensures that the first metal is protected from direct acid attack, the sacrificial anode instead corroding preferentially through the galvanic effect. In addition the transfer of electrons from the second metal to the first metal during the galvanic reaction reduces the tendency of the first metal to oxidise at its surface.

Preferably, the first and second metallic regions of the security device are provided on a first layer.

More preferably, the security device further comprises a first relief structure provided in a surface of the first layer; wherein the first metallic region is provided over a first part of the first relief structure and follows the contours of at least a portion of the first relief structure; and wherein the second metallic region is provided over a second part of the first relief structure and follows the contours of at least a portion of the first relief structure.

In an embodiment of the invention the first layer is embossable, such that the relief structure may be formed by any conventional embossing process including, but not limited to, application of heat, pressure, or both. However, the first layer could also be suitable for cast-curing, such that the relief structure could be formed by cast-curing, including UV curing.

In an embodiment of the invention the first relief structure has first and second spaced parts. However, the relief structure could be continuous, or could have more than two spaced parts.

In an embodiment of the invention at least one metallic region is in contact with the first layer, although in other embodiments there could be one or more additional layers between the first layer and one or more of the metallic regions.

The relief structure is typically a microstructure, such as a diffractive structure, a hologram, and/or a diffraction grating.

A second type of relief structure that may be implemented instead of, or as well as, a diffractive relief structure is a reflective and/or refractive relief structure. Relective and refractive relief structures are coarser than diffractive structures (i.e. having a typical repeat length of greater than 10μm). An example of such relief structures is an array of facets which could be different types of prisms or pyramidal structures. Reflective elements such as facets can be configured to display different intensities (i.e. different brightnesses) at different viewing angles.

In a preferred embodiment of the invention the first metallic region is between the sacrificial anode and the first layer. The purpose of the sacrificial anode is to prevent visible corrosion of the components of the security device, so in embodiments where the sacrificial anode is between the first layer and the first metallic region the sacrificial anode is typically obscured from viewing through the first layer, for example using ink patterns.

In further embodiments of the invention in which the first metallic region is between the sacrificial anode and the first layer, the security device further comprises a third layer, wherein the third layer obscures the sacrificial anode when viewed from the side of the third layer. The third layer could be: a concealing print pattern, composed of the first metal, or composed of the second metal. The third layer could contact the first metallic region, but this is not necessary, or the third layer could be separated from the first metallic region by a barrier layer. The barrier layer could also separate the third layer from the second metallic region, or the third layer could be separated from the first metallic region but in contact with the second metallic region. The barrier layer could be composed of an organic material, or from any other suitable material. Typical barrier materials would be formed from a polymeric binder or resin. Suitable examples include vinyl resins such as UCAR™ VMCA Solution Vinyl Resin or UCAR™ VCMH Solution Vinyl Resin, both of which are supplied by The Dow Chemical Company and which are carboxy-functional terpolymers comprised of vinyl chloride, vinyl acetate and maleic acid.

The third layer could follow the contours of the first relief structure. Alternatively, the third layer could be of a thicknees such that the surface of the third layer furthest from the first relief structure does not follow the contours of the first relief structure. In a further alternative, the surface of the barrier layer furthest from the first relief structure does not follow the contours of the relief structure, such that the third layer also does not follow the contours of the first relief structure. In embodiments where the surface of the barrier layer furthest from the first relief structure does not follow the contours of the first relief structure, a second relief structure could be provided in the barrier layer. This would be visible when the device is viewed from the side of this second relief structure.

The barrier layer could also be: transparent, semi-transparent to all visible light, transparent to some wavelengths of visible light, semi-transparent to some wavelengths of visible light, or opaque. The third layer could be continuous or comprise two or more spaced parts.

However, a third layer is not necessary, in particular when the device is only intended to be viewed from the side of the first layer.

The first metallic region need not be continuous, and could form a pattern.

The second metallic region need not be continuous, and could form a pattern.

The first metal could be copper, whilst the second metal could be aluminium. However, any combination of metals would be suitable in which the second metal has a more negative standard electrode potential than the first metal.

An optional durability layer designed to protect the first layer and first relief structure could be provided on the first layer.

The security device could be provided onto a removable PET carrier layer to form a label and an optional adhesive may be applied to the security device to secure the device to an item of value or other substrate. In other embodiments, the security device is embedded in an item of value, such as a window in a substrate of a document of value, for example a banknote. In a further embodiment, the security device could be incorporated in a security thread. In the embodiment where the security device is a polymer banknote with a transparent window, said transparent portion of the banknote could be incorporated within the multilayer structure of the security device. In such embodiments the polymer banknote substrate replaces the carrier layer. The security device could also be incorporated in a banknote in the form of a security thread.

In accordance with a second aspect of the present invention, there is provided a method for producing a security device comprising: providing a first metallic region composed of a first metal; providing a second metallic region composed of a second metal laterally spaced from the first metallic region, the second metal having a more negative standard electrode potential than the first metal, and wherein the first and second metallic regions are not in contact; and providing at least one sacrificial anode in electrical contact with the metal of the first metallic region but not in electrical contact with the metal of the second metallic region, the at least one sacrificial anode being composed of the second metal.

Preferably, the first and second metallic regions of the security device are provided on a first layer, typically in contact with the first layer although in some cases there could be one or more additional layers between the first layer and one or more of the metallic regions.

More preferably, the method further comprises a step of providing a first relief structure in a surface of a first layer, the first metallic region being provided over a first part of the first relief structure and following the contours of at least a portion of the first relief structure, and the second metallic region being provided over a second part of the first relief structure and following the contours of at least a portion of the first relief structure.

Providing the first metallic region may comprise: applying a water soluble (or other solvent based) ink in areas where the first metal is not required; metalizing the surface of the security device with the first metal; and washing the security device with water (or other solvent) to remove the soluble ink and any metal applied to said soluble ink.

Alternatively, providing the first metallic region may comprise: metalizing the surface of the security device with the first metal; and applying an etchant to the first metal in areas where the first metal is not required, said etchant being specific to the first metal.

Metalizing the surface of the security device with the first metal may comprise vacuum deposition of the first metal, encompassing for example sputtering, resistive boat evaporation, or electron beam evaporation, or it may comprise chemical vapour deposition of the first metal.

Providing the second metallic region and a sacrificial anode may comprise: applying a water soluble (or other solvent based) ink in areas where the second metal is not required, after the first metal has been provided; metalizing the surface of the security device with the second metal; and washing the security device with water (or other solvent) to remove the soluble ink and any metal applied to said soluble ink.

Alternatively, providing the second metallic region and a sacrificial anode may comprise: metalizing the surface of the security device with the second metal, after the first metal has been provided; and applying an etchant to the second metal in areas where the second metal is not required, said etchant being specific to the second metal.

Metalizing the surface of the security device with the second metal may comprise vacuum deposition of the second metal, or it may comprise**.** Metal reflective layers are preferably laid down by vacuum deposition (encompassing for example sputtering, resistive boat evaporation, or electron beam evaporation), or by chemical vapour deposition.

The use of a sacrificial anode composed of the same metal as the second metallic region is advantageous as it reduces the number of manufacturing steps compared with a method that uses three different metals.

Brief Description of the Figures

Some examples of security devices and methods according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 shows an embodiment of the invention in the form of a patch and designed to be viewed from one side only;

Figures 2 to 7 show the steps of a method for producing the embodiment of the invention shown in figure 1;

Figures 8 to 12 show the steps of another method for producing the embodiment of the invention shown in figure 1;

Figures 13 to 16 show embodiments of the invention designed such that the security device may be viewed from either side;

Figures 17a-20c show examples of banknotes carrying security devices according to the embodiments of the invention described herein;

Figure 17a shows a plan view of a polymer banknote with a transparent window region carrying a security device according to the embodiments of the invention described in Figures 13 to 16;

Figure 17b shows a cross-section of the banknote of Figure 17a along the line XX';

Figure 18 shows a plan view of an opaque banknote carrying a security device according to the embodiment of the invention described in Figure 1;

Figure 19a shows a plan view of an opaque banknote with an aperture carrying a security device according to the embodiments of the invention described in figures 13 to 16;

Figure 19b shows a cross-section of the banknote of Figure 19a along the line XX';

Figure 20a shows a plan view of a security document to which a security thread or security strip incorporating the embodiment of the invention described in Figures 13 to 16 has been applied;

Figures 20b and 20c show cross-sections of two alternative constructions of the security document of Figure 20a along the line XX'.

Detailed Description of the Figures

Figure 1 shows an embodiment of the invention in the form of a patch. The patch comprises a carrier layer 11 on which is provided a security device. The carrier layer 11 may be formed from polypropylene and may also be formed from PET, and is typically treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer 11 may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

The security device according to this embodiment comprises a formable (or first) relief layer 13. This layer must be at least semi-transparent to at least some wavelengths of visible light. A first relief structure is provided in two laterally spaced parts or regions

14a and 14b of the layer 13. The relief structures 14a and 14b may be provided in the formable relief layer 13 through any conventional forming technique. Examples of such techniques include, but are not limited to: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. Therefore the relief layer 13 may comprise embossable or curable materials. The formable relief layer 13 may further comprise a curable thermoplastic such that, after embossing, the relief structures 14a and 14b may be fixed by curing. The formable relief layer 13 will have different thicknesses depending on the type of relief structures formed therein, the relief layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the relief layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 13 will have a thickness of up to 50μm, and preferably will have a thickness of 5-30μm.
The relief structures need not be continuous and in this embodiment comprise two distinct, laterally spaced regions, 14a and 14b. In other embodiments, however, there may be any of: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; or two or more distinct, laterally spaced, patterned regions. In some embodiments the relief structure may comprise any of: a microstructure; a diffractive structure; a diffraction grating; a hologram. The relief layer 13 may optionally be provided on a durability layer 12 which is a protective lacquer layer that is typically 1-5 microns thick. Such lacquers are well known in the art and one example is an acrylic based resin. The durability layer provides protection for the relief layer and surface relief structure.

A first metallic region 15 comprising a first metal and with a thickness of 10-30nm is provided over and in contact with a first part of the relief structure 14a of the first layer 13, and this first metallic region follows the contours of the underlying relief structure. In some embodiments the first metal is copper. A second metallic region 16 comprising a second metal and with a thickness of 10-30nm is provided over and in contact with the second part of the relief structure 14b of the first layer 13, and this second metallic region 16 follows the contours of the underlying relief structure. The second metallic region 16 is laterally spaced from, and therefore does not contact, the first metallic region 15. The second metal has a more negative standard electrode potential than the first metal, and in some embodiments the second metal is aluminium.

The second metal is also provided in a further sacrificial region 17 behind the first region 15, the metal of this further region 17 in electrical contact with the metal of the first region 15. In some embodiments there may be two or more distinct, laterally spaced sacrificial regions in electrical contact with the first metallic region 15, as will be described later. The sacrificial region 17 has a thickness of 10-30nm, and in some embodiments has the same thickness as the second metallic region 16. Sacrificial region 17 therefore also follows the contours of the underlying relief structure 14a. As the second metal has a more negative standard electrode potential than the first metal, the region 17 functions as a sacrificial anode, thereby preventing corrosion of the first region 15.

In previous security devices comprising two metallic regions of differing metals there have been problems with galvanic corrosion of the metal with the more negative standard electrode potential and with acid attack on the metal with the higher electrode potential. When the two metallic regions 15 and 16 are in electrical contact a galvanic potential is formed between the first and second metals. This leads to galvanic corrosion of the metal with the more negative standard electrode potential. Previous attempts to prevent this have included separating the two metals to prevent the galvanic potential from being formed. However, when the two metallic regions are laterally spaced, and therefore not in electrical contact, and there is no sacrificial anode the metal with the higher electrode potential is subject to acid attack. By introducing a sacrificial anode 17 behind the first metallic region 15 the acid attack on the first metal is prevented and, since the first metallic region 15 is not in electrical contact with the second metallic region 16, the second metallic region 16 is not subject to galvanic corrosion. Because the sacrificial anode 17 is behind the first metallic region 15 it is hidden from view. The use of a sacrificial anode therefore ensures that there is no visible corrosion of the metal in the security element.

The security device may optionally comprise further metal protection or primer layers 18. These may be the same as the barrier layers mentioned previously, or they may have the specific function of improving the bond between the metal layer and the adhesive layer. An example of such a primer layer can be found in CA2163528. A typical binder system will involve coatings based on acrylic and or vinyl polymer resins. The layer thickness will typically be 0.1-2μm. An adhesive layer 19 is provided in order to secure the security device to a substrate. The adhesive 19 may, in some embodiments, be heat or pressure sensitive. In use the security element is applied to a substrate and heat or pressure is used to activate the adhesive 19. The carrier 11 is then removed.

In the above embodiment, the sacrificial anode 17 is obscured when the device is viewed from the side of the surface relief layer, but would be visible if the device were viewed from the side of the adhesive 19. Such an embodiment is therefore suitable for viewing from one side, and would therefore be suitable for application to an opaque substrate.

Figures 2 to 7 show the steps of a method for producing a security device according to the embodiment of figure 1. This method uses water soluble inks.

In figure 2 a durability layer 12 has been applied to a polypropylene or PET carrier layer 11, the carrier layer having been treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

A formable (first) layer 13 is then applied to the durability layer 12. The formable layer must be at least semi-transparent to at least some wavelengths of visible light, and may comprise embossable or curable materials, and could also be a curable thermoplastic. The durability layer 12 is optional, and in some embodiments the formable layer 13 may be applied directly to the carrier layer 11.

Next, relief structure regions 14a and 14b of the first relief structure are provided on the formable layer 13 through any conventional forming technique, including: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. The relief structures 14a and 14b could also be provided through a combination of the above techniques. Figure 2 shows two distinct, laterally spaced relief structures 14a and 14b, but there may be any of the following: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; or two or more distinct, laterally spaced, patterned regions.

The formable layer 13 will have different thicknesses depending on the type of relief structures formed therein, the formable layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the formable layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 13 will have a thickness of up to 50μm, and preferably will have a thickness of 5-30μm.

Figure 3 shows the steps involved in providing a first metal on the layer 13. First, water soluble ink 31 is applied in the regions where the first metal is not required. The first metal is then applied to the entire surface of the device in a layer 32. Depending on where the water soluble ink 31 has been applied, some areas of the layer 32 will have been applied directly to the formable layer 13, while others will have been applied to the water soluble ink 31. Thus, as shown in figure 3, water soluble ink is applied to a region of the formable layer 13 over the relief structure 14b. The metal which is applied directly to the formable layer is then in a region over and in contact with the relief structure 14a, and this metal will form the metallic region 15. The first metal 32 may be applied by any conventional technique, including vacuum deposition (encompassing for example sputtering, resistive boat evaporation, or electron beam evaporation) and chemical vapour deposition. The first metal may in some embodiments be copper. The layer 32 has a thickness of 10-30nm.

The device is then washed with water, removing the water soluble ink and any areas of the first metal deposited onto the washable ink. The results of this washing are shown in figure 4. A first metallic area 15 of the first metal 32 remains, leaving an area 42 of the formable layer 13 which is exposed. The thickness of the first metallic region 15 means that the first metal follows the contours of the underlying relief structure 14a. In the embodiment shown in figure 4 there is only one first metallic region 15 and only one exposed area 42 of the layer 13. However, in other embodiments there may be more than one first metallic region 15, each region being distinct and laterally spaced from the others. There may also be more than one exposed area 42 of the layer 13, each area being laterally spaced from the others.

Figure 5 shows the steps involved in applying a second metal to the security device. First, water soluble ink 51 is applied to the areas of the security device where the second metal is not required. The second metal is then applied to the entire surface of the device in a layer 52. Depending on where the water soluble ink 51 has been applied, some areas of the layer 52 will have been applied directly to either the formable layer 13 or the first metallic region 15, while others will have been applied to the water soluble ink 51. Thus, as shown in figure 5, water soluble ink is applied to a region of the formable layer 13 directly adjacent to the first metallic region 15 in order that the second metallic region will not contact the first metallic region, but not to the extent that the water soluble ink overlaps the relief structure 14b. Water soluble ink is also applied to regions of the first metallic region 15 such that the sacrificial region 17 will be disposed only over the relief structure 14b, although in other embodiments the sacrificial region or regions could be disposed over any part of the first metallic region 15. The second metal may be applied by any conventional technique, including vacuum deposition (encompassing for example sputtering, resistive boat evaporation, or electron beam evaporation) and chemical vapour deposition. The second metal may in some embodiments be aluminium. The layer 52 has a thickness of 10-30nm.

The device is then washed again with water, removing the water soluble ink and any areas of the second metal deposited onto the washable ink. The results of this washing are shown in figure 6. A second metallic region 16 of the second metal and a sacrificial region 17 of the second metal remain. In this embodiment, areas of the first metallic region 15 remain exposed, although in other embodiments the sacrificial region 17 may cover the first metallic region 15. However, in order for the corrosion of the sacrificial region 17 not to be visible, the sacrificial region 17 must not extend beyond the first metallic region 15. The second metallic region 16 must be laterally spaced from the first metallic region 15 in order that the second metallic region 16 does not also act as a sacrificial anode and corrode. The thickness of the second metallic region 16 means that the second metal follows the contours of the underlying relief structure 14b.

In the embodiment of figures 2 to 7, the second metallic region 16 and the sacrificial region 17 have been laid down at the same time in the same layer 52 and therefore have the same thickness. The sacrificial region 17 therefore also follows the contours of the underlying relief structure 14a. However, in some embodiments the second metallic region 16 may be of a different thickness to the sacrificial region 17 and could be laid down in a separate step. In the embodiment of figures 2 to 7 the security device is designed to be viewed from the side of the layer 13 only. In such an embodiment the sacrificial region 17 does not, therefore, need to follow the contours of the underlying surface relief.

The next step of the method is shown in figure 7 and involves applying metal protection coatings or primers 18 using standard coating printing methods such as rotogravure and flexographic printing. An adhesive layer 19 is then applied to the coating 18. In the embodiment of figures 2 to 7 the security device is designed to be viewed from the side of the layer 13 only, and layers 18 and 19 need not, therefore, be transparent.

Figures 8 to 12 show the steps of another method for producing a security device according to the embodiment of figure 1. This method uses an etchant applied directly to the metallic regions.

In figure 8 a durability layer 12 has been applied to a polypropylene or PET carrier layer 11, the carrier layer having been treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

A formable (first) layer 13 is then applied to the durability layer 12. The formable layer must be at least semi-transparent to at least some wavelengths of visible light, and may comprise embossable or curable materials, and could also be a curable thermoplastic. The durability layer 12 is optional, and in some embodiments the formable layer 13 may be applied directly to the carrier layer 11.

Next, relief structure regions 14a and 14b of a first relief structure are provided in the formable layer 13 through any conventional forming technique, including: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. The relief structures 14a and 14b could also be provided through a combination of the above techniques. Figure 8 shows two distinct, laterally spaced relief structures 14a and 14b, but the may be any of the following: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; or two or more distinct, laterally spaced, patterned regions.

The formable layer 13 will have different thicknesses depending on the type of relief structures formed therein, the formable layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the formable layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 13 will have a thickness of up to 50μm, and preferably will have a thickness of 5-30μm.

In figure 9 a first metal is laid down in a layer 91 over the whole of the formable layer 13. This may be through any conventional technique, including vacuum deposition. In some embodiments this first metal may be copper. The layer 91 has a thickness of 10-30nm. An etchant 92 is then applied to the areas of the layer 91 where the first metal is not required. Areas of the layer 91 coated with the etchant will be removed. Thus, as shown in figure 9, the etchant 92 has been applied to an area over the relief structure 14b, whilst an area over the relief structure 14a has not been coated with the etchant. The metal over the relief structure 14a will form the first metallic region 15, whilst the metal over the relief structure 14b will be removed by the etchant.

Figure 10 shows the structure after an etchant specific to the first metal has been used to remove the targeted regions of layer 91, leaving a first metallic region 15 of the first metal. There is an exposed region 103 of the layer 13 where regions of layer 91 have been removed. The thickness of the first metallic region 15 means that the first metal follows the contours of the underlying relief structure 14a. In the embodiment shown in figure 10 there is only one first metallic region 15 and only one exposed area 103 of the layer 13. However, in other embodiments there may be more than one first metallic region 15, each region being distinct and laterally spaced from the others. There may also be more than one exposed area 103 of the layer 13, each area being laterally spaced from the others.

In the next step, as shown in figure 11, a second metal (such as aluminium) is applied to the security device. Any conventional technique, for example vacuum deposition, may be used to apply a layer 111 of a second metal over the surface of the security device. The layer 111 has a thickness of 10-30nm. An etchant is then applied to specific regions omitting the areas 112a and 112b where the second metal is required and removing metal 111 in the regions where it is not required. . An area adjacent to the first metallic area 15 in particular has been removed by the etchant, such that the first metallic area 15 will not be in electrical contact with the second metallic area 16.

Figure 12 shows the results of applying the etchant to the second metal and the subsequent steps of the method. The etched regions of the layer 111 have been removed, leaving a sacrificial region 17 over a portion of the first metallic region 15, as well as a second metallic region 16 2b over a portion of the previously exposed layer 13. The thickness of the second metallic region 16 means that the second metal follows the contours of the underlying relief structure 14b. In the embodiment shown in figure 12 there is only one sacrificial region 17, but in further embodiments there may be additional sacrificial regions. All such regions must be in electrical contact with the first metallic region 15 and must not be visible when the security device is viewed from the side of the layer 13. The embodiment of figure 12 also shows a continuous second metallic region 16. However, this region may be discontinuous so as to form a pattern. In all embodiments of the invention, the second metallic region must not be in electrical contact with the first metallic region.

The etchant will be specific on the metal being used, however as an example a caustic NaOH solution would be suitable for etching Aluminium and the following etchant could be used for copper:

Hydrochloric acid	50%v
Ferric chloride (40° Baumé) (Room temperature)	50%v

In the embodiment of figures 8 to 12 the sacrificial region 17 and the second metallic region 16 have been laid down as part of a single layer 111, and therefore have the same thickness. However, in further embodiments the sacrificial region 17 could have a different thickness to the second metallic region 16 and could be laid down in a separate step. Furthermore, in embodiments where the security device is only intended to be viewed from the side of the layer 13, such as in figures 8-12, the sacrificial region 17 need not follow the contours of the underlying relief structure 14a.

The method concludes by applying metal protection coatings or primers 18 followed by an adhesive layer 19. In the embodiment of figures 8 to 12 the security device is designed to be viewed from the side of the layer 13 only, and layers 18 and 19 need not, therefore, be transparent.

Figure 13 shows another embodiment of the invention in the form of a transfer stripe or a patch. The security device shown in this figure comprises a carrier layer 131 on which is provided a security device. The carrier layer 131 may be formed from polypropylene and may also be formed from PET, and is typically treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer 131 may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

The security device according to this embodiment comprises a formable (first) relief layer 133. This layer must be at least semi-transparent to at least some wavelengths of visible light. Relief structure regions 134a and 134b of a first relief structure are provided in the layer 133. The relief structures 134a and 134b may be provided in the formable relief layer 133 through any conventional forming technique. Examples of such techniques include, but are not limited to: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. Therefore the relief layer 133 may comprise embossable or curable materials. The formable relief layer 133 may further comprise a curable thermoplastic such that, after embossing, the relief structures 134a and 134b may be fixed by curing.

The relief structures need not be continuous and in this embodiment comprise two distinct, laterally spaced regions, 134a and 134b. In other embodiments, however, there may be any of: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; two or more distinct, laterally spaced, patterned regions. In some embodiments the relief structure may comprise any of: a microstructure; a diffractive structure; a diffraction grating; a hologram. The relief layer 133 may optionally be provided on a durability layer 132, the durability layer providing protection for the relief layer and surface relief structure.

The formable layer 133 will have different thicknesses depending on the type of relief structures formed therein, the formable layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the formable layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 133 will have a thickness of up to 50μm, and preferably will have a thickness of 5-30μm.

A first metallic region 135 comprising a first metal and with a thickness of 10-30nm is provided over and in contact with a first part of the relief structure 134a, and this first metallic region follows the contours of the underlying relief structure. In some embodiments the first metal is copper. A second metallic region 136 comprising a second metal and with a thickness of 10-30nm is provided over and in contact with the second part of the relief structure 134b, and this second metallic region 136 follows the contours of the underlying relief structure. The second metallic region 136 is laterally spaced from, and therefore does not contact, the first metallic region 135. The second metal has a more negative standard electrode potential than the first metal, and in some embodiments the second metal is aluminium.

The second metal is also provided in two sacrificial regions 137a and 137b behind the first region 135, the metal of these sacrificial regions 137a and 137b in electrical contact with the metal of the first region 135. In some embodiments there may be only one sacrificial region in electrical contact with the first metallic region 135 and in other embodiments there may be more than two distinct, laterally spaced sacrificial regions in electrical contact with the first metallic region 135. The metallic regions 137a and 137b have thicknesses of 10-30nm, and in some embodiments have the same thickness as the second metallic region 136. In other embodiments the two or more sacrificial regions may each have different thicknesses. In the embodiment of figure 13, sacrificial regions 137a and 137b are not over the relief structure 134a. However, in embodiments where there is at least one sacrificial region with an underlying relief structure, said sacrificial region(s) will follow the contours of the underlying relief structure or structures. As the second metal has a more negative standard electrode potential than the first metal, the regions 137a and 137b function as sacrificial anodes, thereby preventing corrosion of the first region 135.

The security device may optionally comprise further metal protection or primer layers 139. An adhesive layer 1310 is provided in order to secure the security device to a substrate. The adhesive 1310 may, in some embodiments, be heat or pressure sensitive. In use the security element is applied to a substrate and heat or pressure is used to activate the adhesive 1310. The carrier 131 is then removed. In this embodiment both the primer layers 139 and the adhesive layer 1310 must be at least semi-transparent to at least some wavelengths of visible light.

The embodiment of figure 13 is a development of the embodiment of figure 1 in which an additional layer of the first metal 138 is provided on both the first metallic region 135 and the sacrificial regions 137a and 137b, obscuring the sacrificial regions 137a and 137b when the security device is viewed from the side of the adhesive layer 1310. Such an embodiment is therefore suitable for viewing from both sides of the security device and would therefore be suitable for application to a transparent substrate, for example a window in a polymer bank note.

Vapour deposited metal layers are not completely uniform and there are usually some cracks or holes in the coverage such that the electrolyte contacts both metals, but preferably first metal 138 is applied in the form of a fine screen, i.e. a repeating grid of dots, lines, or other indicia to enable contact between the electrolyte and both metals, thus allowing a galvanic cell to be formed. Preferably, the coverage of the screen pattern is in the range 20-80%, and more preferably in the range 40-70% and even more preferably in the range 50-60%. The width of the lines or the diameter of the dots forming the screen are preferably in the range 50-300µm and the spaces between the dots or lines are also in the range 50-300µm with values of each set chosen to achieve the desired screen coverage. The screen can be regular or stochastic. Indeed, the term “screen” should be construed broadly to encompass many different shapes of screen elements including those which convey information such as alphanumeric characters or pictorial symbols.

Figure 14 shows another embodiment of the invention in the form of a transfer stripe or a patch. The security device shown in this figure comprises a carrier layer 141 on which is provided a security device. The carrier layer 141 may be formed from polypropylene and may also be formed from PET, and is typically treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer 141 may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

The security device according to this embodiment comprises a formable (first) relief layer 143. This layer must be at least semi-transparent to at least some wavelengths of visible light. Relief structure regions 144a and 144b of a first relief structure are provided in the layer 143. The relief structures 144a and 144b may be provided in the formable relief layer 143 through any conventional forming technique. Examples of such techniques include, but are not limited to: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. Therefore the relief layer 143 may comprise embossable or curable materials. The formable relief layer 143 may further comprise a curable thermoplastic such that, after embossing, the relief structures 144a and 144b may be fixed by curing.

The relief structures need not be continuous and in this embodiment comprise two distinct, laterally spaced regions, 144a and 144b. In other embodiments, however, there may be any of: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; two or more distinct, laterally spaced, patterned regions. In some embodiments the relief structure may comprise any of: a microstructure; a diffractive structure; a diffraction grating; a hologram. The relief layer 143 may optionally be provided on a durability layer 142, the durability layer providing protection for the relief layer and surface relief structure.

The formable layer 143 will have different thicknesses depending on the type of relief structures formed therein, the formable layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the formable layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 143 will have a thickness of up to 50µm, and preferably will have a thickness of 5-30µm.

A first metallic region 145 comprising a first metal and with a thickness of 10-30nm is provided over a first part of the relief structure 144a, and this first metallic region follows the contours of the underlying relief structure. In some embodiments the first metal is copper. A second metallic region 146 comprising a second metal and with a thickness of 10-30nm is provided over the second part of the relief structure 144b, and this second metallic region 146 follows the contours of the underlying relief structure. The second metallic region 146 is laterally spaced from, and therefore does not contact, the first metallic region 145. The second metal has a more negative standard electrode potential than the first metal, and in some embodiments the second metal is aluminium.

The second metal is also provided in two sacrificial regions 147a and 147b behind the first region 145, the metal of these sacrificial regions 147a and 147b in contact with the metal of the first region 145. In some embodiments there may be only one sacrificial region in electrical contact with the first region 145 and in other embodiments there may be more than two sacrificial regions in electrical contact with the first region 145. The metallic regions 147a and 147b have thicknesses of 10-30nm, and in some embodiments have the same thickness as the second metallic region 146. In other embodiments the two or more sacrificial regions may each have different thicknesses. In the embodiment of figure 14, sacrificial regions 147a and 147b are not over the relief structure 144a. However, in embodiments where there is at least one sacrificial region with an underlying relief structure, said sacrificial regions follow the contours of the underlying relief structure or structures. As the second metal has a more negative standard electrode potential than the first metal, the regions 147a and 147b function as sacrificial anodes, thereby preventing corrosion of the first region 145.

The security device may optionally comprise further metal protection or primer layers 1410. An adhesive layer 1411 is provided in order to secure the security device to a substrate. The adhesive 1411 may, in some embodiments, be heat or pressure sensitive. In use the security element is applied to a substrate and heat or pressure is used to activate the adhesive 1411. The carrier 141 is then removed. In this embodiment both the primer layers 1410 and the adhesive layer 1411 must be at least semi-transparent to at least some wavelengths of visible light.

Figure 14 is a development of figure 1 in which an organic barrier layer 148 is provided on both the first metallic region and the sacrificial regions, and should be substantially transparent to at least some wavelengths of visible light to enable the optically variable effect of the relief structure 144a to be visible from both sides of the device. This organic barrier layer 148 typically has a thickness of 1-5 μm when the relief structures are diffractive (or up to 50μm in the case of refractive relief, reflective relief, or thin film interference structures), with the surface of the barrier layer 148 furthest from the relief structure 144a being planar such that this surface does not follow the contours of the relief structure. Typical barrier materials would be formed from a polymeric binder or resin. Suitable examples include vinyl resins such as UCAR™ VMCA Solution Vinyl Resin or UCAR™ VCMH Solution Vinyl Resin, both of which are supplied by The Dow Chemical Company and which are carboxy-functional terpolymers comprised of vinyl chloride, vinyl acetate and maleic acid.

On this organic barrier layer 148 are provided concealing regions 149a and 149b of the second metal such that the sacrificial regions are obscured when viewed from the side of the adhesive layer 1411. These concealing regions 149a, 149b also allow a different pattern to be seen when the device is viewed from the side of the adhesive as from when it is viewed from the side of the layer 143. In embodiments with differing numbers of sacrificial regions a concealing region is provided for each sacrificial region, so that all sacrificial regions are obscured when the security device is viewed from the side of the adhesive layer. Further metallic regions could also be provided on the organic layer 148 depending on the desired pattern. Concealing regions 149a and 149b could also be a different metal from the second metal. The organic barrier layer serves as an additional protection layer and further serves to separate concealing regions 149a and 149b from the sacrificial anode, such that they do not undergo galvanic corrosion. Such an embodiment is therefore suitable for viewing from both sides of the security device and would therefore be suitable for application to a transparent substrate, for example a window in a polymer bank note.

Figure 15 shows another embodiment of the invention in the form of a transfer stripe or a patch. The security device shown in this figure comprises a carrier layer 151 on which is provided a security device. The carrier layer 151 may be formed from polypropylene and may also be formed from PET, and is typically treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer 151 may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

The security device according to this embodiment comprises a formable (first) relief layer 153. This layer must be at least semi-transparent to at least some wavelengths of visible light. Relief structure regions 154a and 154b of a first relief structure are provided in the layer 153. The relief structures 154a and 154b may be provided in the formable relief layer 153 through any conventional forming technique. Examples of such techniques include, but are not limited to: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. Therefore the relief layer 153 may comprise embossable or curable materials. The formable relief layer 153 may further comprise a curable thermoplastic such that, after embossing, the relief structures 154a and 154b may be fixed by curing.

The relief structures need not be continuous and in this embodiment comprise two distinct, laterally spaced regions, 154a and 154b. In other embodiments, however, there may be any of: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; two or more distinct, laterally spaced, patterned regions. In some embodiments the relief structure may comprise any of: a microstructure; a diffractive structure; a diffraction grating; a hologram. The relief layer 153 may optionally be provided on a durability layer 152, the durability layer providing protection for the relief layer and surface relief structure.

The formable layer 153 will have different thicknesses depending on the type of relief structures formed therein, the formable layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the formable layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 153 will have a thickness of up to 50μm, and preferably will have a thickness of 5-30μm.

A first metallic region 155 comprising a first metal and with a thickness of 10-30nm is provided over a first part of the relief structure 154a, and this first metallic region follows the contours of the underlying relief structure. In some embodiments the first metal is copper. A second metallic region 156 comprising a second metal and with a thickness of 10-30nm is provided over the second part of the relief structure 154b, and this second metallic region 156 follows the contours of the underlying relief structure 154b. The second metallic region 156 is laterally spaced from, and therefore does not contact, the first metallic region 155. The second metal has a more negative standard electrode potential than the first metal, and in some embodiments the second metal is aluminium.

The second metal is also provided in two sacrificial regions 157a and 157b behind the first region 155, the metal of these sacrificial regions 157a and 157b in contact with the metal of the first region 155. In some embodiments there may be only one sacrificial region in electrical contact with the first region 155 and in other embodiments there may be more than two sacrificial regions in electrical contact with the first region 155. The metallic regions 157a and 157b have thicknesses of 10-30nm, and in some embodiments have the same thickness as the second metallic region 156. In other embodiments the two or more sacrificial regions may each have different thicknesses. In the embodiment of figure 15, sacrificial regions 157a and 157b are not over the relief structure 154a. However, in embodiments where there is at least one sacrificial region with an underlying relief structure, said sacrificial regions follow the contours of the underlying relief structure or structures. As the second metal has a more negative standard electrode potential than the first metal, the regions 157a and 157b function as sacrificial anodes, thereby preventing corrosion of the first region 155.

The security device may optionally comprise further metal protection or primer layers 1511. An adhesive layer 1512 is provided in order to secure the security device to a substrate. The adhesive 1512 may, in some embodiments, be heat or pressure sensitive. In use the security element is applied to a substrate and heat or pressure is used to activate the adhesive 1512. The carrier 151 is then removed. In this embodiment both the primer layers 1511 and the adhesive layer 1512 must be at least semi-transparent to at least some wavelengths of visible light.

Figure 15 is a development of figure 1 in which an organic barrier layer 158 is provided on both the first metallic region and the sacrificial regions. This organic layer typically has a thickness of 1-5 μm when the relief structures are diffractive (or up to 50μm in the case of refractive relief, reflective relief, or thin film interference structures), such that the surface of the organic layer furthest from the relief structures 154a and 154b does not follow the contours of said relief structures. Typical barrier materials would be formed from a polymeric binder or resin. Suitable examples include vinyl resins such as UCAR™ VMCA Solution Vinyl Resin or UCAR™ VCMH Solution Vinyl Resin, both of which are supplied by The Dow Chemical Company and which are carboxy-functional terpolymers comprised of vinyl chloride, vinyl acetate and maleic acid.

Since the surface of the organic layer furthest from the relief structures 154a and 154b does not follow the contours of said relief structures, further relief structures 159a-d may be provided onto the organic layer 158, with 159c and 159d being provided above sacrificial regions 157a and 157b. Concealing regions 1510a-d of the second metal are provided over each further relief structure. As such sacrificial regions 157a and 157b are obscured when viewed from the side of the adhesive layer. Any number of further relief structures may be provided on the organic layer, a concealing region provided over each, so long as each sacrificial region in the embodiment is obscured when the security device is viewed from the side of the adhesive layer. Not all such relief structures need to be provided over a sacrificial region, however. The effect of relief structures 159a-d and regions 1510a-d is that a different holographic image is seen when the security device is viewed from the direction of the adhesive layer 1512 as when viewed from the direction of layer 153. Concealing regions 1510a-d could also be a different metal from the second metal. The organic barrier layer serves as an additional protection layer and further serves to separate concealing regions 1510a-d from the sacrificial anode, such that they do not undergo galvanic corrosion. Such an embodiment is therefore suitable for viewing from both sides of the security device and would therefore be suitable for application to a transparent substrate, for example a window in a polymer bank note.

Figure 16 shows another embodiment of the invention in the form of a transfer stripe or a patch. The security device shown in this figure comprises a carrier layer 161 on which is provided a security device. The carrier layer 161 may be formed from polypropylene and may also be formed from PET, and is typically treated, for example with corona discharge or with a wax release layer (not shown), so that the carrier layer 161 may be detached in a controllable way. The carrier layer has a thickness of 10-50μm, and may in some embodiments have a thickness of 12-23μm.

The security device according to this embodiment comprises a formable relief layer 163. This layer must be at least semi-transparent to at least some wavelengths of visible light. Relief structure regions 164a and 164b of a first relief structure are provided in the layer 163. The relief structures 164a and 164b may be provided in the formable relief layer 163 through any forming technique. Examples of such techniques include, but are not limited to: embossing; cast-curing, including UV cast-curing; and applying heat and/or pressure. Therefore the relief layer 153 may comprise embossable or curable materials. The formable relief layer 153 may further comprise a curable thermoplastic such that, after embossing, the relief structures 154a and 154b may be fixed by curing.

The relief structures need not be continuous and in this embodiment comprise two distinct, laterally spaced regions, 164a and 164b. In other embodiments, however, there may be any of: a single, continuous relief structure; a single, patterned relief structure; two or more distinct, laterally spaced, continuous regions; two or more distinct, laterally spaced, patterned regions. In some embodiments the relief structure may comprise any of: a microstructure; a diffractive structure; a diffraction grating; a hologram. The relief layer 163 may optionally be provided on a durability layer 162, the durability layer providing protection for the relief layer and surface relief structure.

The formable layer 163 will have different thicknesses depending on the type of relief structures formed therein, the formable layer having a thickness greater than that of the relief structures. Diffractive or holographic relief structures will have a thickness of 1-5μm, and preferably will have a thickness of 1-3μm, with the formable layer having a thickness of 1-7μm. In alternative embodiments where refractive or reflective relief structures are used, the layer 163 will have a thickness of up to 50μm, and preferably will have a thickness of 5-30μm.

A first metallic region 165 comprising a first metal and with a thickness of 10-30nm is provided over a first part of the relief structure 164a, and this first metallic region follows the contours of the underlying relief structure. In some embodiments the first metal is copper. A second metallic region 166 comprising a second metal and with a thickness of 10-30nm is provided over the second part of the relief structure 164b, and this second metallic region 166 follows the contours of the underlying relief structure 164b. The second metallic region 166 is laterally spaced from, and therefore does not contact, the first metallic region 165. The second metal has a more negative standard electrode potential than the first metal, and in some embodiments the second metal is aluminium.

The second metal is also provided in two sacrificial regions 167a and 167b behind the first region 165, the metal of these sacrificial regions 167a and 167b in electrical contact with the metal of the first region 165. In some embodiments there may be only one sacrificial region in electrical contact with the metal of the first region 165 and in other embodiments there may be more than two sacrificial regions in electrical contact with the metal of the first region 165. The metallic regions 167a and 167b have thicknesses of 10-30nm, and in some embodiments have the same thickness as the second metallic region 166. In other embodiments the two or more sacrificial regions may each have different thicknesses. In the embodiment of figure 16, sacrificial regions 167a and 167b are not over the relief structure 164a. However, in embodiments where there is at least one sacrificial region with an underlying relief structure, said sacrificial regions follow the contours of the underlying relief structure or structures. As the second metal has a more negative standard electrode potential than the first metal, the regions 167a and 167b function as sacrificial anodes, thereby preventing corrosion of the first region 165.

The security device may optionally comprise further metal protection or primer layers 169. An adhesive layer 1610 is provided in order to secure the security device to a substrate. The adhesive 1610 may, in some embodiments, be heat or pressure sensitive. In use the security element is applied to a substrate and heat or pressure is used to activate the adhesive 1610. The carrier 161 is then removed. In this embodiment both the primer layers 169 and the adhesive layer 1610 must be at least semi-transparent to at least some wavelengths of visible light.

In the embodiment of figure 16, a concealing print pattern (168a and 168b) is provided over the sacrificial regions 167a and 167b, obscuring the sacrificial regions when the security device is viewed from the side of the adhesive layer. The sacrificial regions may therefore be provided on the first metallic region 165 in a pattern such that when the device is viewed from the side of the adhesive layer 1610 an ink pattern is seen. Such an embodiment is therefore suitable for viewing from both sides of the security device and would therefore be suitable for application to a transparent substrate, for example a window in a polymer bank note. Further ink patterns may optionally be provided in areas where there is no sacrificial anode.

The embodiments described in figures 13 to 16 may be produced using variations on the methods shown in figures 2 to 7 or 8 to 12 by incorporating additional steps to provide the further regions and layers shown in figures 13 to 16.

Figures 1 to 16 each show a cross section of an embodiment of the invention, but this should not be taken as limiting the appearance of the security device along other cross sections. Any of the regions and layers described above could be continuous or discontinuous along other cross sections, the only requirements being that: regions of the first metal be in electrical contact with a sacrificial region of the second metal; the sacrificial region or regions not be visible to a user of the security device; non-sacrificial regions of the second metal not be in electrical contact with any regions of the first metal.

Figures 17a to 20cdepict examples of security documents in which security devices of the types described above have been incorporated.

Figures 17a and 17b show a first exemplary security document, here a banknote 1701, in (a) plan view and (b) cross-section along line XX'. Here, the banknote 1701 is a polymer banknote, comprising an internal transparent polymer substrate 1703 which is coated on each side with opacifying layers 1704a and 1704b in a conventional manner. In some cases, the opacifying layers may be provided on one side of the substrate 1703 only. The opacifying layers 1704a and 1704b are omitted in a region of the document so as to define a window 1702, here having a square shape. Within the window region

1702 is located a security device 1700 in accordance with any of the embodiments discussed above. The outer perimeter of the device 1700 is denoted by the dashed circular line surrounding the “sun shaped” optically variable effect region. The security device 1700 may be formed integrally in the banknote 1701 with the relief structure being formed directly in the surface of transparent substrate 1703, the transparent substrate thereby acting as the formable (first) relief layer, or the security device 1700 may be formed integrally in the banknote 1701 with the transparent substrate 1703 replacing the carrier layer. Alternatively, the security device 1700 may have been formed separately as a security article such as a transfer stripe, a patch, or a label. In this case, the security device 1700 may be affixed to the transparent substrate 1703 inside the window region 1702 by means of a transparent adhesive. Application may be achieved by a hot or cold transfer method e.g. hot stamping.

It should be noted that a similar construction could be achieved using a paper/plastic composite banknote in which the opacifying layers 1704a and 1704b are replaced by paper layers laminated (with or without adhesive) to an internal transparent polymer layer 1703. The paper layers may be omitted from the window region from the outset, or the paper could be removed locally after lamination. In other constructions, the order of the layers may be reversed with a (windowed) paper layer on the inside and transparent polymer layers on the outside.

In Figure 18 the banknote 1801 is of conventional construction having a substrate 1803 formed for example of paper or other relatively opaque or translucent material. The security device 1700 is applied as a patch to join the security article to the document substrate 1803. Again, the application of the security device and document could be achieved using various methods including hot stamping.

In Figures 19a and 19b, the banknote 1901 is of conventional construction having a substrate 1903 formed for example of paper or other relatively opaque or translucent material. The window region 1902 is formed as an aperture through the substrate 1903. The security device 1700 is applied as a patch overlapping the edges of window 1902 utilising transparent adhesive to join the edges of the security article to the document substrate 1903. Again, the application of the security device and document could be achieved using various methods including hot stamping.

Figures 20a, 20b, and 20c depict another example of a security document, again a banknote, to which a security article 2003 in the form of a security thread or security strip has been applied. Three security devices 1700 each carried on the strip 2003 are revealed through windows 2002, arranged in a line on the document 2001. Two alternative constructions of the document are shown in cross-section in Figures 20b and 20c. Figure 20b depicts the security thread or strip 2003 incorporated within the security document 2001. For example, the security thread or strip 2003 may be incorporated within the substrate's structure during the paper making process using well known techniques. To form the windows 2002, the paper may be removed locally after completion of the paper making process, e.g. by abrasion, leaving opacifying regions 2004a and 2004b. Alternatively, the paper making process could be designed so as to omit paper in the desired window regions. Figure 20c shows an alternative arrangement in which the security thread or strip 2003 carrying the security device 1700 is applied to one side of document substrate 2005, e.g. using adhesive. The windows 2002 are formed by provision of apertures in the substrate 2005, which may exist prior to the application of strip 150 or be formed afterwards, again for example by abrasion.

Many alternative techniques for incorporating security documents of the sorts discussed above are known and could be used. For example, the above described device structures could be formed directly on other types of security document including identification cards, driving licenses, bankcards and other laminate structures, in which case the security device may be incorporated directly within the multilayer structure of the document, the substrate typically replacing the carrier layer in the security device.

Claims

1. A security device comprising:

a first metallic region composed of a first metal;

a second metallic region composed of a second metal laterally spaced from the first metallic region, the second metal having a more negative standard electrode potential than the first metal, and wherein the first and second metallic regions are not in contact; and

at least one sacrificial anode in electrical contact with the metal of the first metallic region but not in electrical contact with the metal of the second metallic region, the at least one sacrificial anode being composed of the second metal.

2. The security device of claim 1, wherein the first and second metallic regions are provided on a first layer.

3. The security device of claim 2, wherein the security device further comprises a first relief structure provided in a surface of the first layer; wherein the first metallic region is provided over a first part of the first relief structure and follows the contours of at least a portion of the first relief structure; and wherein the second metallic region is provided over a second part of the first relief structure and follows the contours of at least a portion of the first relief structure.

4. The security device of claim 3, wherein the first layer is embossable.

5. The security device of claim 3 or claim 4, wherein the first relief structure has at least first and second spaced parts.

6. The security device of any of claims 2 to 5, wherein the first relief structure comprises a microstructure.

7. The security device of any of claims 2 to 6, wherein the first relief structure comprises a diffractive structure.

8. The security device of any of claims 2 to 7, wherein the first relief structure comprises a diffraction grating.

9. The security device of any of claims 2 to 7, wherein the first relief structure comprises a hologram.

10. The security device of any of claims 2 to 9, wherein the first relief structure comprises a refractive structure.

11. The security device of any of claims 2 to 10, wherein the first relief structure comprises a reflective structure.

12. The security device of any of claims 1 to 11, wherein the security device is designed to be viewed from the side of the of the first metallic region furthest from the sacrificial anode, such that the sacrificial anode is obscured.

13. The security device of any of claims 1 to 12, further comprising a third layer, wherein the third layer obscures the sacrificial anode when viewed from the side of the third layer.

14. The security device of claim 13, wherein the third layer comprises a concealing print pattern.

15. The security device of claim 13, wherein the third layer is composed of the first metal.

16. The security device of claim 13, wherein the third layer is composed of the second metal.

17. The security device of any of claims 13 to 15, wherein the third layer is in contact with the first metallic region.

18. The security device of any of claims 13, 14, or 16, wherein the third layer is separated from the first metallic region by a barrier layer.

19. The security device of claim 18, wherein the barrier layer also separates the third layer from the second metallic region.

20. The security device of claim 18 or claim 19, wherein the barrier layer is composed of an organic material.

21. The security device of any of claims 13 to 20 when dependent on claim 3, wherein the third layer follows the contours of the first relief structure.

22. The security device of any of claims 18 to 20 when dependent on claim 3, wherein the surface of the barrier layer furthest from the first relief structure does not follow the contours of the first relief structure.

23. The security device of claim 22, wherein a second relief structure is provided in the barrier layer.

24. The security device of any of claims 17 to 23, wherein the barrier layer is transparent.

25. The security device of any of claims 13 to 24, wherein the third layer is not continuous.

26. The security device of any of claims 1 to 25, wherein the first metallic region is not continuous.

27. The security device of any of claims 1 to 26, wherein the second metallic region is not continuous.

28. The security device of any of claims 1 to 27, wherein the first metal is copper.

29. The security device of any of claims 1 to 28, wherein the second metal is aluminium.

30. The security device of any of claims 1 to 29, wherein the security device is provided on a durability layer.

31. The security device of any of claims 1 to 30, wherein the security device is provided on a removable PET carrier layer.

32. The security device of any of claims 1 to 31, further comprising an adhesive over the security device.

33. The security device of any of claims 1 to 32, wherein one or more additional layers are provided between the first layer and one or more of the metallic regions.

34. The security device of any of claims 1 to 33, wherein the security device is one of: a transfer band or sheet, a security thread, a foil, a patch, a label, or a strip.

35. A document, or article, of value carrying a security device according to any of the preceding claims.

36. The document of claim 35, wherein the document is one of: a banknote, a cheque, an identification document, a certificate, a share, a visa, a passport, a driver's licence, a bank card, or an ID card.

37. A method for producing a security device comprising:

providing a first metallic region composed of a first metal;

providing a second metallic region composed of a second metal laterally spaced from the first metallic region, the second metal having a more negative standard electrode potential than the first metal, and wherein the first and second metallic region are not in contact; and

providing at least one sacrificial anode in electrical contact with the metal of the first metallic region but not in electrical contact with the metal of the second metallic region, the at least one sacrificial anode being composed of the second metal.

38. The method of claim 37, wherein the first and second metallic regions are provided on a first layer.

39. The method of claim 38, the method further comprising an initial step of providing a first relief structure in a surface of the first layer;

the first metallic region being provided over a first part of the first relief structure and following the contours of at least a portion of the first relief structure; and

the second metallic region being provided over a second part of the first relief structure and following the contours of at least a portion of the first relief structure.

40. The method of any of claims 37 to 39, wherein providing a first metallic region comprises:

applying a water soluble ink in areas where the first metal is not required;

metalizing the surface of the security device with the first metal; and

washing the security device with water to remove the water soluble ink and any metal applied to said water soluble ink.

41. The method of any of claims 37 to 39, wherein providing a first metallic region comprises:

metalizing the surface of the security device with the first metal; and

applying an etchant to the first metal in areas where the first metal is not required, said etchant being specific to the first metal.

42. The method of claim 40 or claim 41, wherein metalizing the surface of the security device with the first metal comprises vacuum deposition of the first metal.

43. The method of any of claims 37 to 42, wherein providing a second metallic region and a sacrificial anode comprises:

applying a water soluble ink in areas where the second metal is not required, after the first metal has been provided;

metalizing the surface of the security device with the second metal; and

washing the security device with water to remove the water soluble ink and any metal applied to said water soluble ink.

44. The method of any of claims 37 to 42, wherein providing a second metallic region comprises:

metalizing the surface of the security device with the second metal, after the first metal has been provided; and

applying an etchant to the second metal in areas where the second metal is not required, said etchant being specific to the second metal.

45. The method of claim 43 or claim 44, wherein metalizing the surface of the security device with the second metal comprises vacuum deposition of the second metal.