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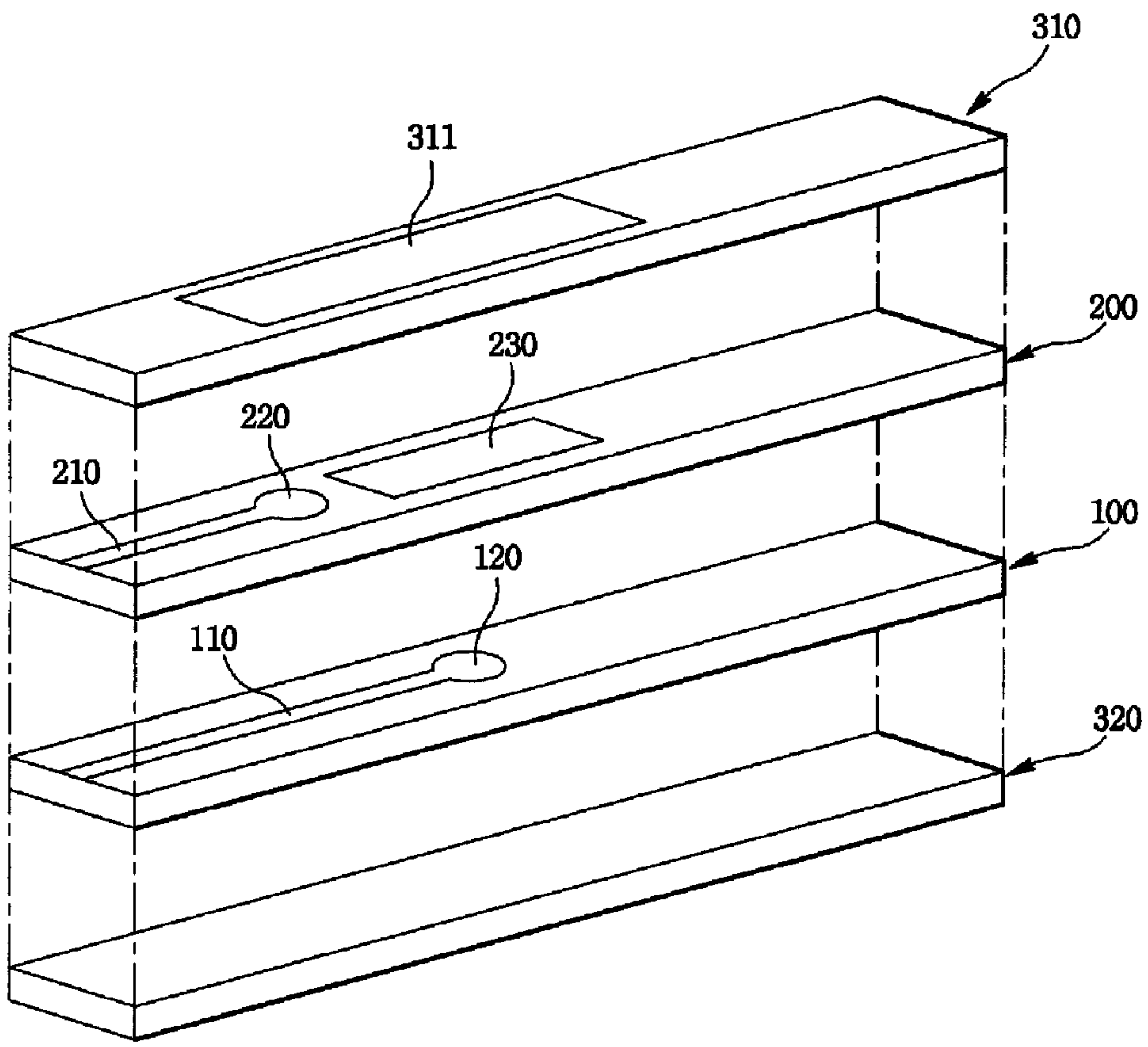
(54) Titre : BANDE MULTICOUCHE ET SYSTEME DE MESURE DE BIOMATERIAU
(54) Title: MULTI-LAYER STRIP FOR USE IN MEASURING BIOLOGICAL MATERIAL AND SYSTEM FOR MEASURING BIOLOGICAL MATERIAL



(57) **Abrégé/Abstract:**
The multi-layer strip for use in measuring biological material and the system for measuring a biological material are provided, wherein the multi-layer strip includes a stack of a plurality of strips, each having a flow channel and a reaction unit, and the strips

(57) Abrégé(suite)/Abstract(continued):

may react with specific materials contained in a biological material injected into the multi-layer strip, whereby Thus, it is possible to quantitatively analyze various materials contained in a biological material and to optically and electrochemically measure and quantitatively analyze various materials in a biological material.

ABSTRACT OF THE DISCLOSURE

The multi-layer strip for use in measuring biological material and the system for measuring a biological material are provided, wherein the multi-layer strip includes a stack of a plurality of strips, each having a flow channel and a reaction unit, and the strips may react with specific materials contained in a biological material injected into the multi-layer strip, whereby Thus, it is possible to quantitatively analyze various materials contained in a biological material and to optically and electrochemically measure and quantitatively analyze various materials in a biological material.

MULTI-LAYER STRIP FOR USE IN MEASURING BIOLOGICAL MATERIAL AND SYSTEM FOR MEASURING BIOLOGICAL MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multi-layer for use in measuring biological material and a system for measuring biological material.

2. Description of the Related Art

Devices capable of measuring and analyzing biological materials have recently been developed and widely used in the medical field.

Such biological material measurement devices determine whether body fluid such as blood, urine or saliva contains specific materials and thus determine whether individuals are healthy.

For example, in order to control and monitor diabetes, the amount of glucose in blood may need to be periodically measured.

In order to measure glucose, portable glucose measurement devices or strip-type bio sensors may be used.

Various types of devices such as portable measurement devices or stripe-type bio sensors may be used to measure and analyze biological materials. However, conventional biological material measurement devices alone cannot selectively analyze specific materials (e.g., glucose) contained in a biological material sample. Therefore, conventional biological material measurement devices have limited effectiveness and limited range of application.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention there is provided a multi-layer strip for use in measuring a biological material. The multi-layer strip includes a stack of a plurality of same size strips, each strip including a flow channel through which a biological material is injected into each strip and a reaction unit which reacts with the biological material. Each strip also includes a transparent region which transmits light therethrough so that the light can reach the reaction unit of a corresponding underlying strip. Each distal end of the plurality of strips is matched to each other. The multi-layer strip also includes a plurality of reaction-inducing material layers which are respectively immobilized in the reaction units of the strips and react with the biological material.

The reaction-inducing material layers may react with each different specific material contained in the biological material.

The reaction units of the strips may not overlap each other so that light perpendicularly incident upon the multi-layer strip can smoothly transmit through the multi-layer strip.

The multi-layer strip may include upper and lower cover strips which may be stacked onto the top and the bottom, respectively, of the stack, one of the upper cover strips, and the lower cover strips and both the upper and lower cover strips may include a transparent region which transmits light therethrough so that the light can reach the reaction units of the strips.

The flow channels and the reaction units may be formed as grooves or through holes.

The multi-layer strip may include a plurality of sensing electrode patterns which may be respectively formed in the reaction units of the strips, each of the reaction-inducing material layers may be formed on the sensing electrode patterns.

The biological material may be a body fluid.

The strips may be transparent strips partially covered with an opaque material layer, and regions of the strips not covered with the opaque material layer may be defined as the transparent regions.

The flow channels may be respectively connected to the reaction units.

A distal end formed at each flow channel may be exposed on one side of the stack.

Each of the flow channels may be formed with a width to transmit a liquid-phase biological material to the respective reaction units by provisions of a capillary phenomenon.

The flow channels may be nano channels.

A transparent region may be partially formed on a sidewall of the stack and transmit light therethrough so that the light can reach the reaction units of the strips.

The strips may be transparent strips partially covered with an opaque material layer, and regions of the strips not covered with the opaque material layer may be defined as the transparent regions.

In accordance with another aspect of the invention there is provided a system for measuring a biological material. The system includes a multi-layer strip which includes a stack of a plurality of same size strips and a plurality of reaction-inducing material layers, each strip including a flow channel through which a biological material is injected into each strip and a reaction unit which reacts with the biological material, the reaction-inducing material layers being immobilized in the reaction units of the strips and reacting with the biological material. Each strip includes a transparent region which transmits light therethrough so that the light can reach the reaction unit of a corresponding underlying strip and each distal end of the plurality of strips is matched to each other. The system also includes an optical processing module which optically measures the degree of reaction of the biological material with the reaction-inducing material layers and quantitatively analyzes the results of the optical measurement.

Some of the plurality of strips may include a sensing electrode pattern which is formed in the reaction unit and the reaction-inducing material layer may be formed on the sensing electrode pattern, and the system may further include an electrochemical processing module which electrochemically measures the degree of reaction of the biological material with the reaction-inducing material layers and quantitatively analyzes the results of the electrochemical measurement.

The reaction-inducing material layers may each react with different specific materials contained in the biological material.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings, in which:

FIG. **1** illustrates an exploded perspective view of a multi-layer strip for use in measuring a biological material according to an embodiment of the present invention;

FIGS. **2**A and **2**B illustrate diagrams for explaining a method of optically analyzing biomaterials using the multi-layer strip illustrated in FIG. **1**, according to an embodiment of the present invention;

FIG. **3** illustrates a cross-sectional view of a multi-layer strip for use in measuring a biological material according to an embodiment of the present invention;

FIG. **4** illustrates a cross-sectional view of an embodiment of the multi-layer strip illustrated in FIG. **1**;

FIG. **5** illustrates a cross-sectional view of another embodiment of the multi-layer strip illustrated in FIG. **1**;

FIG. **6** illustrates a cross-sectional view for explaining a method of forming a transparent region in a strip according to an embodiment of the present invention;

FIG. **7** illustrates an exploded perspective view of a multi-layer strip for measuring a biological material according to another embodiment of the present invention;

FIG. **8** illustrates an exploded perspective view of a multi-layer strip for measuring a biological material according to another embodiment of the present invention;

FIG. **9** illustrates a block diagram of a system for measuring a biological material according to an embodiment of the present invention;

FIG. **10** illustrates a perspective view of a multi-layer strip for measuring a biological material according to another embodiment of the present invention; and

FIG. **11** illustrates a diagram of an embodiment of the multi-layer strip illustrated in FIG. **10**, which is partially covered with an opaque material layer.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown.

FIG. **1** illustrates an exploded perspective view of a multi-layer strip for use in measuring a biological material according to an embodiment of the present invention. Referring to FIG. **1**, the multi-layer strip includes a stack of first and second strips **100** and **200**. The first strip **100** includes a first flow channel **110** through which a biological material is injected into the first strip **100**; and a first reaction unit **120** which reacts with the biological material. Likewise, the second strip **200** includes a second flow channel **210** through which the biological material is injected into the second strip **200**; and a second reaction unit **220** which reacts with the biological material.

Reaction-inducing materials (not shown) that react with specific materials contained in the predetermined biological material may be respectively immobilized in the first and second reaction units **120** and **220**.

Preferably, the reaction-inducing materials immobilized at the reaction units(**120**,**220**) of the first and second strip(**100**,**200**) are the ones that react with other specific materials contained in the biological materials.

In short, the reaction-inducing material layers react with each different specific materials contained in the biological material.

For example, a reaction-inducing material that reacts with cholesterol may be immobilized in the first reaction unit **120** of the first strip **100**, and a reaction-inducing material that reacts with hemoglobin may be immobilized in the second reaction unit **220** of the second strip **200**.

The predetermined biological material may be a body fluid such as blood, urine, serum, saliva, or urine.

The first and second flow channels **110** and **210** may be nano-channels each having a width of several nanometers to several hundreds of nanometers and may thus enable a liquid-phase biological material to be injected into the first and second reaction units **120** and **220** by means of a capillary phenomenon.

The first flow channel **110** may be connected to the first reaction unit **120**, and the second flow channel **210** may be connected to the second reaction unit **220**.

The multi-layer strip is illustrated in FIG. **1** as including a stack of two strips, but the present invention is not restricted to this. That is, the multi-layer strip may be a stack of more than two strips.

Since a biological material is injected into and reacts with each of the multi-layer strip, it is possible to quantitatively analyze a plurality of specific materials contained in the biological material by optically or electrochemically analyzing the degree to which the specific materials reacts with the multi-layer strip. For example, when blood is injected into the multi-layer strip, it is possible to quantitatively analyze a number of components of blood such as glucose, cholesterol, and hemoglobin.

In short, the multi-layer strip of the embodiment of FIG. **1** includes a stack of a plurality of strips, each having a flow channel and a reaction unit; and a plurality of reaction-inducing material layers which are immobilized in the respective strips and can react with specific materials contained in a biological material.

The multi-layer strip of the embodiment of FIG. **1** optically measures the degree of reaction of a biological material injected thereinto with the first and second reaction units **120** and **220** of the first and second strips **100** and **200**. The first and second reaction units **120** and **220** of the first and second strips **100** and **200** do not overlap each other so that light perpendicularly incident thereupon can smoothly transmit through each of the strips. Each of the first and second strips **100** and **200** may include a transparent region which can transmit light therethrough so that the light can reach the reaction unit of a corresponding underlying strip, if any.

Referring to FIG. **1**, the second strip **200** includes a transparent region **230** which is disposed close to the second reaction unit **220**. The first reaction unit **120** of the first strip **100** is disposed below the transparent region **230** of the second strip **200**.

Referring to FIG. **1**, the multi-layer strip also includes upper and lower cover strips **310** and **320** which are attached onto the top and the bottom, respectively, of a stack of the first and second strips **100** and **200**.

At least one of the upper and lower cover strips **310** and **320** may include a transparent region **311** which can transmit light therethrough so that the light can reach the first and second reaction units **120** and **220** of the first and second strips **100** and **200**.

FIG. **1** does not illustrated any transparent region formed at the lower cover strip **320**.

FIGS. **2**A and **2**B illustrate diagrams for explaining a method of optically analyzing a biological material using the multi-layer strip illustrated in FIG. **1**. Referring to FIGS. 2A and **2**B, when a biological material is injected into a reaction unit **520** of a strip **500** through a flow channel **510**, a specific material contained in the biological material reacts with a reaction-inducing material layer **530** immobilized in the reaction unit **520**.

Then, referring to FIG. **2**A, a light emitter **610** irradiates light onto an area in which the reaction of the specific material in the biological material with the reaction-inducing material layer **530** takes place, and a light receiver **611** detects light reflected from the strip **500**.

Alternatively, referring to FIG. **2**B, the light emitter **610** irradiates light onto the area where the reaction of the specific material in the biological material with the reaction-inducing material layer **530** takes place, and the light receiver **611** detects light transmitted through the strip **500**.

Thereafter, the specific material in the biological material may be quantitatively analyzed based on the amount of light detected by the light receiver **611**.

A color variation at a region where the specific material contained in the biological material and the reaction-inducing material layer **530** is measured, and the specific material can be quantitatively analyzed by a intensity of light reflected from or transmitted through the reaction-inducing material layer **530**.

FIG. **3** illustrates a cross-sectional view of a muti-layer strip for use in measuring a biological material according to an embodiment of the present invention.

Referring to FIG. **3**, a second strip **200** is deposited on a first strip **100**. The first strip **100** includes a first flow channel through which a biological material can be injected into the multi-layer strip and a first reaction unit which can react with the biological material. Likewise, the second strip **200** includes a second flow channel through which a biological material can be injected into the multi-layer strip and a second reaction unit which can react with the biological material.

The first and second reaction units of the first and second strips **100** and **200** do not overlap each other.

The second strip **200** includes a transparent region **230** which can transmit light therethrough so that the light can reach the first reaction unit of the first strip **100**.

Reaction-inducing material layers **121** and **221** are respectively formed in the first and second reaction units of the first and second strips **100** and **200**.

The first and second flow channels and the first and second reaction units of the first and second strips **100** and **200** may be formed as grooves or through holes, as illustrated in FIG. **3**, so that a biological material can be smoothly injected into the stack of the first and second strips **100** and **200**.

FIG. **4** illustrates a cross-sectional view of an embodiment of the multi-layer strip illustrated in FIG. **1**. Referring to FIG. **4**, upper and lower cover strips **310** and **320** are attached onto the top and the bottom, respectively, of a stack **400** of first and second strips **100** and **200**.

In order to irradiate light onto the first and second reaction units of the first and second strips **100** and **200**, a transparent region **311** may be formed over a wide area of the upper cover strip **310**.

A transparent region (not shown) may also be formed in the second strip **200** so that light incident upon the second strip **200** can transmit through the second strip **200** and can be incident upon the first reaction unit of first strip **100**.

In the embodiment of FIG. **4**, like in the embodiment of FIG. 2A, a light emitter, which is disposed above the upper cover strip **310**, irradiates light onto the multi-layer strip, and a light receiver, which is also disposed above the upper cover strip **310**, detects light reflected from a reaction point in the multi-layer strip.

The reaction point may be a place where a biological material injected into the multi-layer strip reacts with a reaction-inducing material in the multi-layer strip. Referring to FIG. **4**, first and second reaction-inducing material layers **121** and **221** are respectively formed in the first and second reaction units of the first and second strips **100** and **200**.

FIG. **5** illustrates a cross-sectional view of another embodiment of the multi-layer strip illustrated in FIG. **1**. Referring to FIG. **5**, a transparent region **311** is formed in an upper cover strip **310**, which is stacked onto a stack **400** of the first and second strips **100** and **200**. The transparent region **311** may be used to irradiate light onto the first and second reaction units of the first and second strips **100** and **200**.

A transparent region **321** is formed in a lower cover strip **320**, which is attached onto the bottom of the stack **400**. The transparent region **321** transmits therethrough light transmitted through the first and second reaction units of the first and second strips **100** and **200**.

Transparent regions **131** and **132** are formed in the first strip **100**, and transparent regions **231** and **232** are formed in the second strip **200**. The transparent regions **311**, **321**, **131**, **132**, **231** and **232** are connected to one another, and thus, light incident upon the multi-layer strip can smoothly transmit through the multi-layer strip.

That is, in order to enable light irradiated onto the first reaction unit of the first strip **100** through the transparent region **311** of the upper cover strip **310** to reach the transparent region **321** of the lower cover strip **320** through a reaction point in the multi-layer strip, portion A of the multi-layer strip may be formed to be transparent, as illustrated in FIG. **5**.

In addition, in order to enable light irradiated onto the second reaction unit of the second strip **200** through the transparent region **311** of the upper cover strip **310** to reach the transparent region **321** of the lower cover strip **320** through the reaction point in the multi-layer strip, portion B of the multi-layer strip may be formed to be transparent, as illustrated in FIG. **5**.

In the embodiment of FIG. **5**, like in the embodiment of FIG. **2B**, a light emitter, which is disposed above the upper cover strip **310**, irradiates light onto the multi-layer strip, and a light receiver, which is disposed below the lower cover strip **320**, detects light transmitted through a reaction point in the multi-layer strip.

FIG. **6** illustrates a cross-sectional view of a method of forming a transparent region in a strip according to an embodiment of the present invention. In order to form a transparent region in the plurality of strips, the plurality of strips are formed with transparent strips, and the transparent strips are patterned by opaque material layer.

The transparent region of the plurality of strips may be defined by the strip region not covered with the opaque material layer.

That is, referring to FIG. **6**, when opaque material layer patterns **550** are formed on a transparent strip **501**, the regions of the transparent strip **501** on which the opaque material layer patterns **550** are formed may be defined as non-transparent regions that cannot transmit light therethrough, and region of the transparent strip **501** on which the opaque material layer patterns **550** are not formed may be defined as a transparent region that can transmit light therethrough.

FIG. **7** illustrates an exploded perspective view of a multi-layer strip for measuring a biological material according to another embodiment of the present invention. Referring to FIG. **7**, the multi-layer strip includes a stack of first and second strips **100** and **200**. The first and second strips **100** and **200** include first and second reaction units **120** and **220**, respectively. First and second reaction-inducing material layers **121** and **221** are immobilized in the first and second reaction units **120** and **220**, respectively, and may react with specific materials contained in a biological material injected into the multi-layer strip.

The multi-layer strip of the embodiment of FIG. **7** electrochemically measures the degree of reaction of a biological material injected thereinto with the reaction units of the first and second strips **100** and **200**. For this, first and second sensing electrode patterns **150** and **250** are formed in the first and second reaction units **120** and **220**, respectively. First and second reaction-inducing material layers **121** and **221** are formed on the first and second sensing electrode patterns **150** and **250**, respectively.

The first and second sensing electrode patterns **150** and **250** detect current variations resulting from the reaction of the first and second reaction-inducing material layers **121** and **221** with a biological material injected into the multi-layer strip.

The first and second sensing electrode patterns **150** and **250** may be triode patterns, each having a working electrode, a reference electrode and a counter electrode.

FIG. **8** illustrates an exploded perspective view of a multi-layer strip for measuring a biological material according to another embodiment of the present invention. Referring to FIG. **8**, the multi-layer strip includes a stack of a plurality of strips **750** and

710. The strip **750** optically measures a biological material, and the strip **710** electrochemically measures a biological material.

Alternatively, the multi-layer strip may include a stack of a plurality of strips and a strip for electrochemically measuring a biological material.

The multi-layer strip may also include upper and lower cover strips **310** and **320**. The upper cover strip **310** may include a transparent region **311** which can transmit light therethrough so that the light can reach a reaction unit **752** of the strip **750**.

The strips **710** and **750** include flow channels **711** and **751**, respectively, through which a biological material can be injected into the multi-layer strip, and reaction units **712** and **752**, respectively, which react with the biological material.

A reaction-inducing material layer **753** is immobilized in the reaction unit **752** of the strip **750**.

A sensing electrode pattern **720** is formed in the reaction unit **712** of the strip **710**, and a reaction-inducing material layer **730** is formed on the sensing electrode pattern **720**.

The multi-layer strip of the embodiment of FIG. **8** can measure a biological material optically and electrochemically.

FIG. **9** illustrates a block diagram of a system for measuring a biological material according to an embodiment of the present invention. Referring to FIG. **9**, the system includes a multi-layer strip **800** and an optical processing module **810** which optically measures the degree of reaction of a biological material with a plurality of reaction-inducing material layers immobilized in the multi-layer strip **800** and quantitatively analyzes the results of the measurement.

The system may also include an electrochemical processing module **820** which electrochemically measures the degree of reaction of a biological material with the reaction-inducing material layers immobilized in the multi-layer strip **800** and quantitatively analyzes the results of the measurement.

Once a biological material is injected into the multi-layer strip **800**, the system can measure and quantitatively analyze the biological material by detecting color variations and signal variations resulting from the reaction of the biological material with the reaction-inducing material layers in the multi-layer strip **800** with the aid of the optical processing module **810** and the electrochemical processing module **820**.

The optical processing module **810** may include a light emitter which irradiates light onto a reaction point in the multi-layer strip **800**; a light receiver which receives light reflected from or transmitted through the reaction point; and an analysis unit which quantitatively analyzes a specific material in a biological material injected into the multi-layer strip **800** based on the amount of light received by the light receiver.

The analysis unit of the optical processing module **810** may include a monitor. In this case, a user may monitor the color of each reaction point in the multi-layer strip **800** through the monitor.

The electrochemical processing module **820** quantitatively analyzes a specific material in a biological material injected into the multi-layer strip **800** by applying a voltage to a sensing electrode pattern of the multi-layer strip **800** and detecting a current variation resulting from the reaction of the biological material with a reaction-inducing material layer on the sensing electrode pattern.

FIG. **10** illustrates a perspective view of a multi-layer strip for measuring a biological material according to another embodiment of the present invention. Referring to FIG. **10**, a transparent region is formed on a sidewall of a stack **800** of a plurality of strips. The transparent region can transmit light therethrough so that the light can reach the reaction units of the strips.

Since the transparent region is formed on a sidewall of the stack **800**, there is no need to form a transparent region in each of the strips. Therefore, it is possible to facilitate the manufacture of a multi-layer strip.

The strips may all be transparent strips, and a portion of a sidewall of the stack **800** not covered with an opaque material layer may be defined as the transparent region.

A distal end formed at each flow channel **810**, which are formed in the respective strips, may be exposed on one side of the stack **800**.

FIG. **11** illustrates a diagram of a multi-layer strip partially covered with an opaque material layer, according to an embodiment of the present invention. Referring to FIG. **11**, in order to form a transparent region on one sidewall of a stack **800** of a plurality of strips as performed in the embodiment of FIG. **10**, an opaque material layer may be partially formed on a sidewall of the stack **800**.

Then, portions of the sidewall of the stack **800** covered with the opaque material layer are defined as opaque regions **820** and **840**, whereas a portion of the sidewall of the stack **800** covered with the opaque material layer is defined as a transparent region **830**. As a result, light irradiated for measuring the reaction of a biological material can penetrate into the stack **800** only through the transparent region **830**.

As described above, according to the present invention, a multi-layer strip includes a stack of a plurality of strips, each having a flow channel and a reaction unit, and the strips may react with specific materials contained in a biological material injected into the multi-layer strip. Thus, it is possible to quantitatively analyze various materials contained in a biological material. In addition, it is possible to optically and electrochemically measure and quantitatively analyze various materials in a biological material.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A multi-layer strip for use in measuring a biological material, the multi-layer strip comprising:

    a stack of a plurality of same size strips, each strip comprising a flow channel through which a biological material is injected into each strip and a reaction unit which reacts with the biological material, wherein each strip comprises a transparent region which transmits light therethrough so that the light can reach the reaction unit of a corresponding underlying strip and wherein each distal end of the plurality of strips is matched to each other; and

    a plurality of reaction-inducing material layers which are respectively immobilized in the reaction units of the strips and react with the biological material.

2. The multi-layer strip of claim **1**, wherein the reaction-inducing material layers react with each different specific materials contained in the biological material.

3. The multi-layer strip of claim **1**, wherein the reaction units of the strips do not overlap each other so that light perpendicularly incident upon the multi-layer strip can smoothly transmit through the multi-layer strip.

4. The multi-layer strip of claim **1**, further comprising upper and lower cover strips which are stacked onto the top and the bottom, respectively, of the stack, wherein one of the upper cover strips, the lower cover strips and both the upper and lower cover strips comprises a transparent region which transmits light therethrough so that the light can reach the reaction units of the strips.

5. The multi-layer strip of claim **1**, wherein the flow channels and the reaction units are formed as grooves or through holes.

6. The multi-layer strip of claim **1**, further comprising a plurality of sensing electrode patterns which are respectively formed in the reaction units of the strips, wherein each of the reaction-inducing material layers is formed on the sensing electrode patterns.

7. The multi-layer strip of claim **1**, wherein the biological material is a body fluid.

8. The multi-layer strip of claim **4**, wherein the strips are transparent strips partially covered with an opaque material layer, and regions of the strips not covered with the opaque material layer are defined as the transparent regions.

9. The multi-layer strip of claim **1**, wherein the flow channels are respectively connected to the reaction units.

10. The multi-layer strip of claim **1**, wherein a distal end formed at each flow channel is exposed on one side of the stack.

11. The multi-layer strip of claim **10**, wherein each of the flow channels is formed with a width to transmit a liquid-phase biological material to the respective reaction units by means of a capillary phenomenon.

12. The multi-layer strip of claim **11**, wherein the flow channels are nano channels.

13. The multi-layer strip of claim **1**, wherein a transparent region is partially formed on a sidewall of the stack and transmits light therethrough so that the light can reach the reaction units of the strips.

14. The multi-layer strip of claim **13**, wherein the strips are transparent strips partially covered with an opaque material layer, and regions of the strips not covered with the opaque material layer are defined as the transparent regions.

15. A system for measuring a biological material, the system comprising:

a multi-layer strip which includes a stack of a plurality of same size strips and a plurality of reaction-inducing material layers, each strip comprising a flow channel through which a biological material is injected into each strip and a reaction unit which reacts with the biological material, the reaction-inducing material layers being immobilized in the reaction units of the strips and reacting with the biological material, wherein each strip comprises a transparent region which transmits light therethrough so that the light can reach the reaction unit of a corresponding underlying strip and wherein each distal end of the plurality of strips is matched to each other; and

an optical processing module which optically measures the degree of reaction of the biological material with the reaction-inducing material layers and quantitatively analyzes the results of the optical measurement.

16. The system of claim **15**, wherein some of the plurality of strips comprise a sensing electrode pattern which is formed in the reaction unit and the reaction-inducing material layer is formed on the sensing electrode pattern, and the system further comprises an electrochemical processing module which electrochemically measures the degree of reaction of the biological material with the reaction-inducing material layers and quantitatively analyzes the results of the electrochemical measurement.

17. The system of claim **15**, wherein the reaction-inducing material layers each react with different specific materials contained in the biological material.

FIG. 1

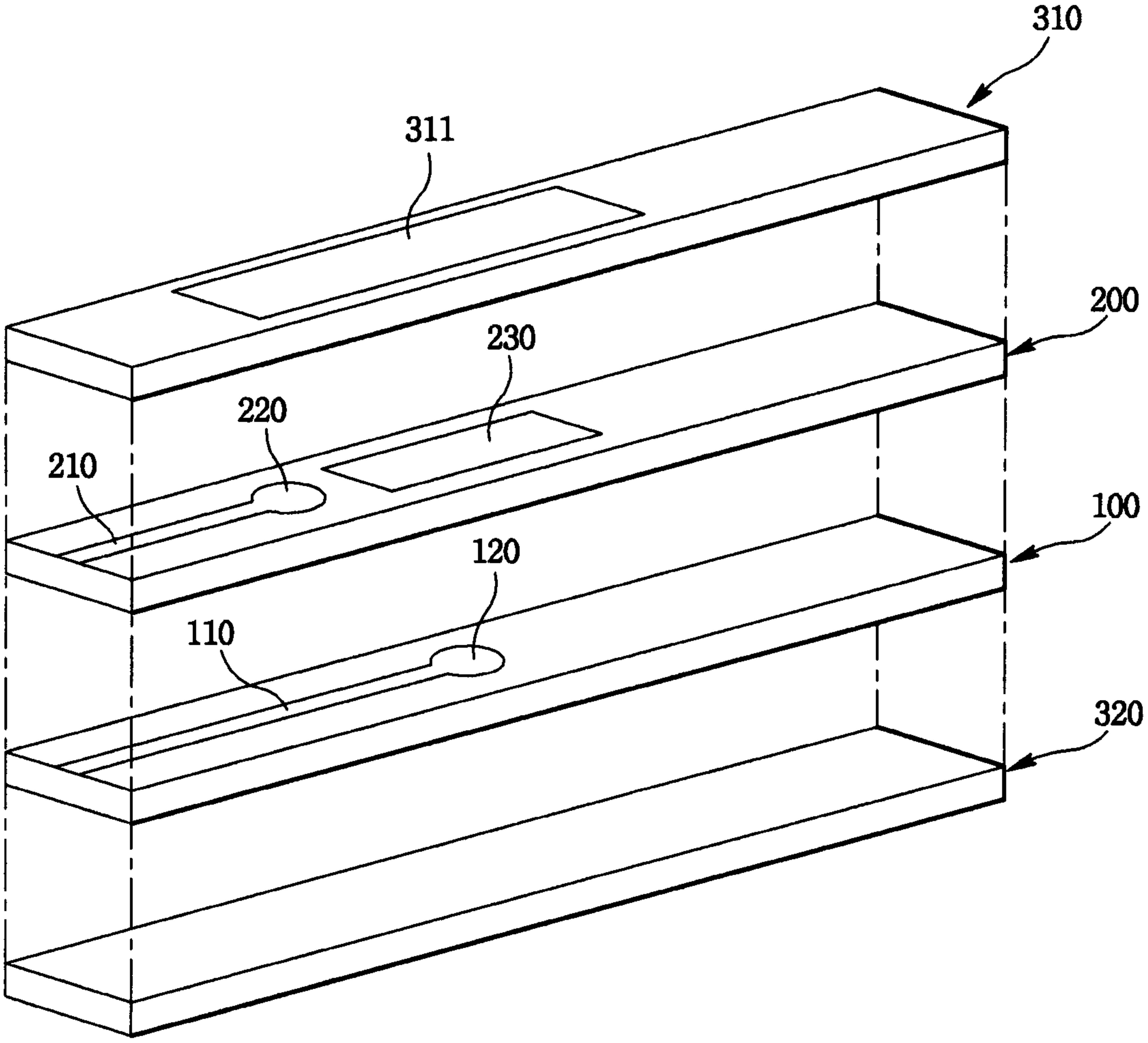


FIG. 2A

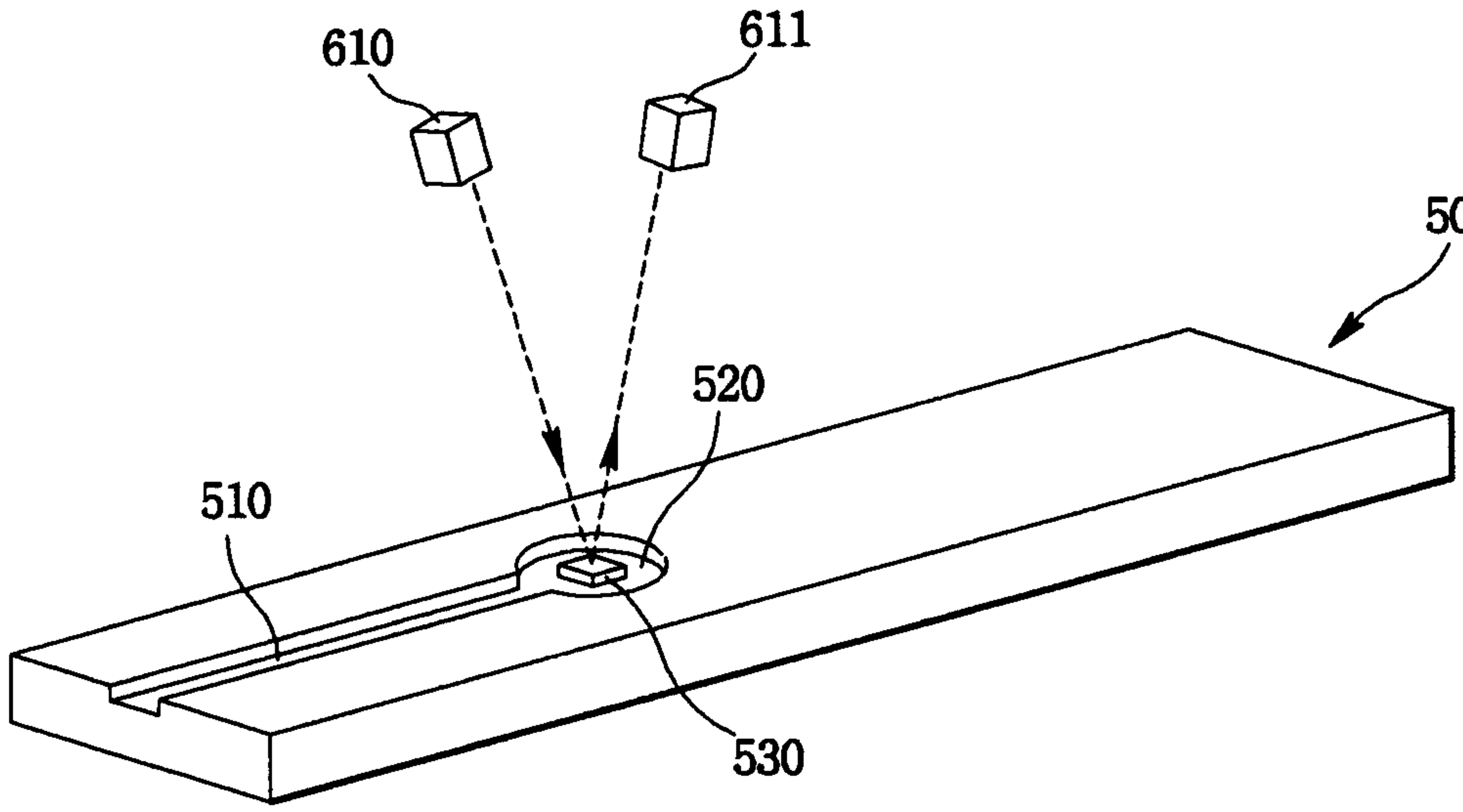


FIG. 2B

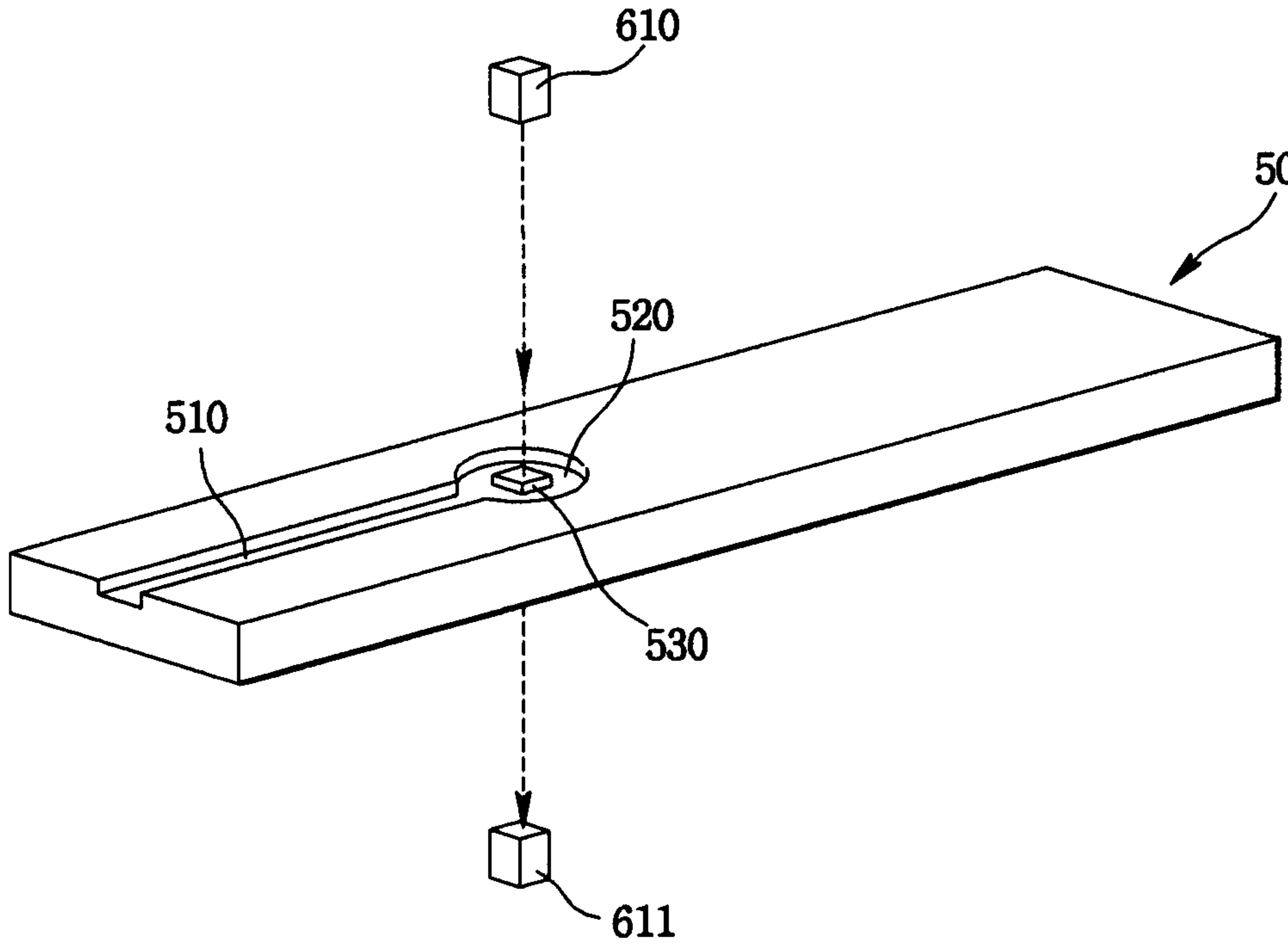


FIG. 3

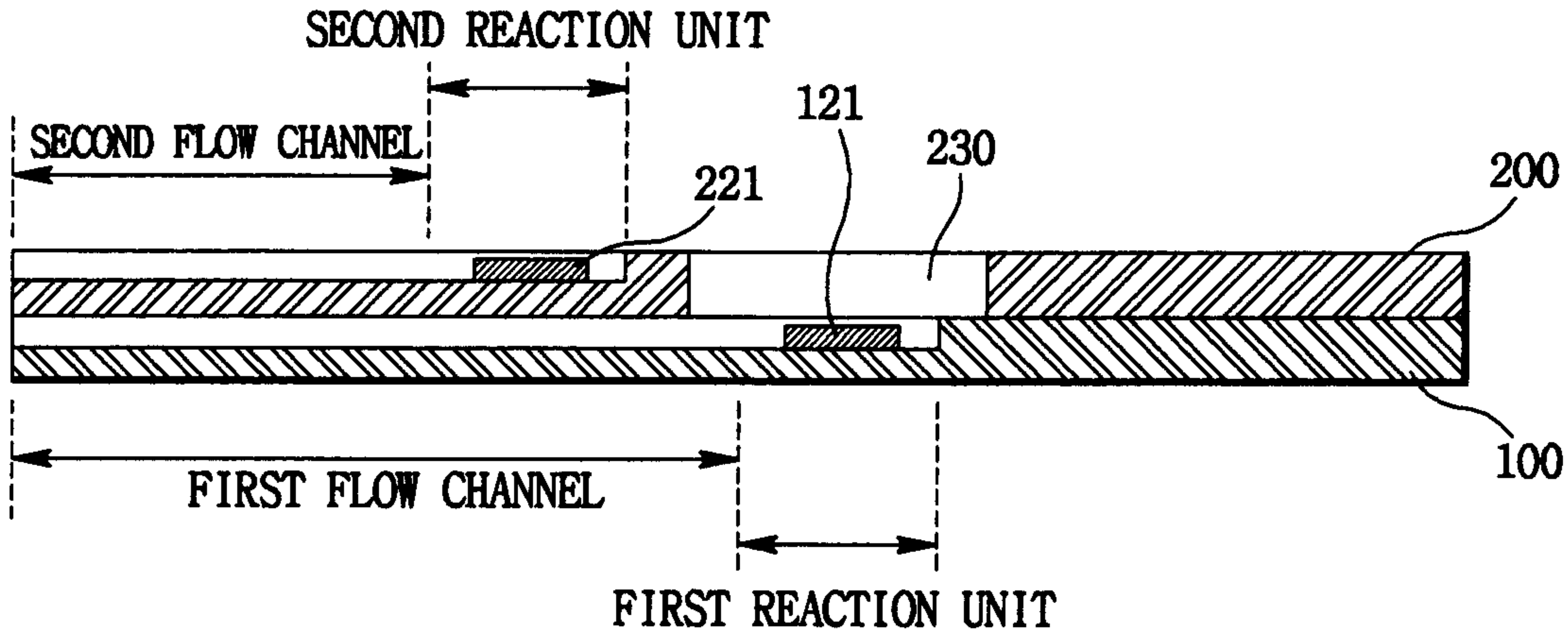

SECOND REACTION UNIT
SECOND FLOW CHANNEL
121
230
221
200
100
FIRST FLOW CHANNEL
FIRST REACTION UNIT

FIG. 4

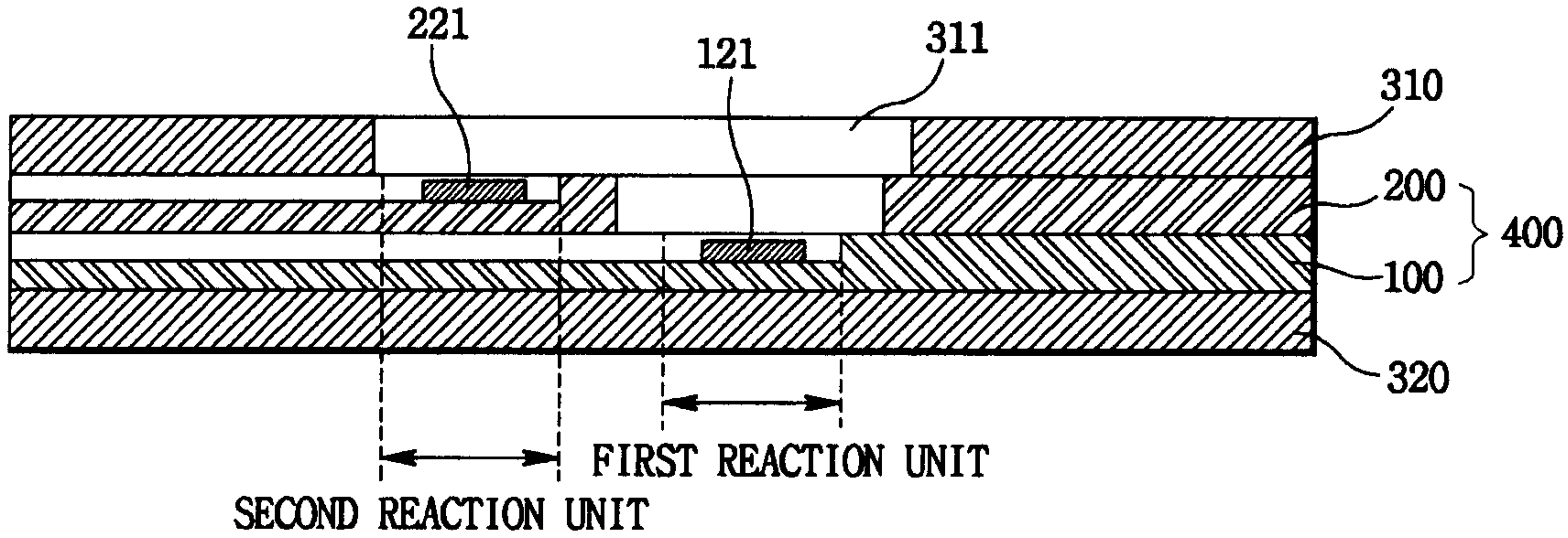

221
121
311
310
200
400
100
320
FIRST REACTION UNIT
SECOND REACTION UNIT

FIG. 5

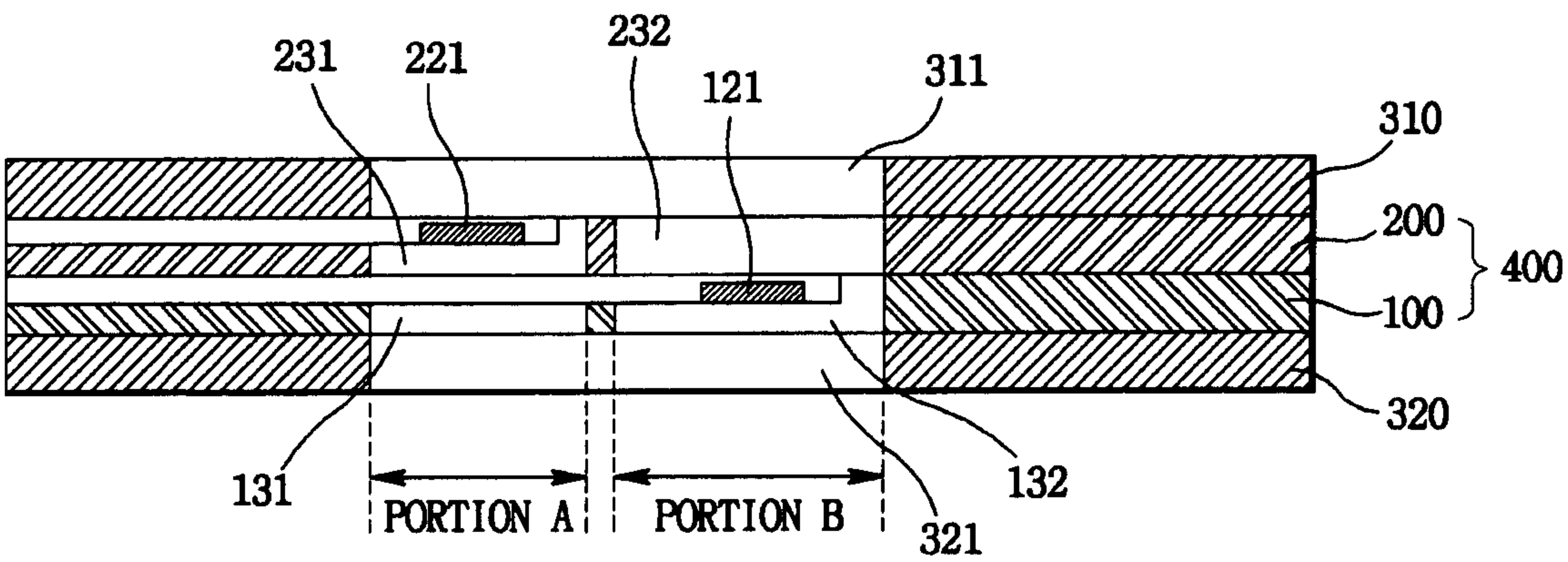

231
221
232
121
311
310
200
400
100
320
131
PORTION A
PORTION B
132
321

FIG. 6

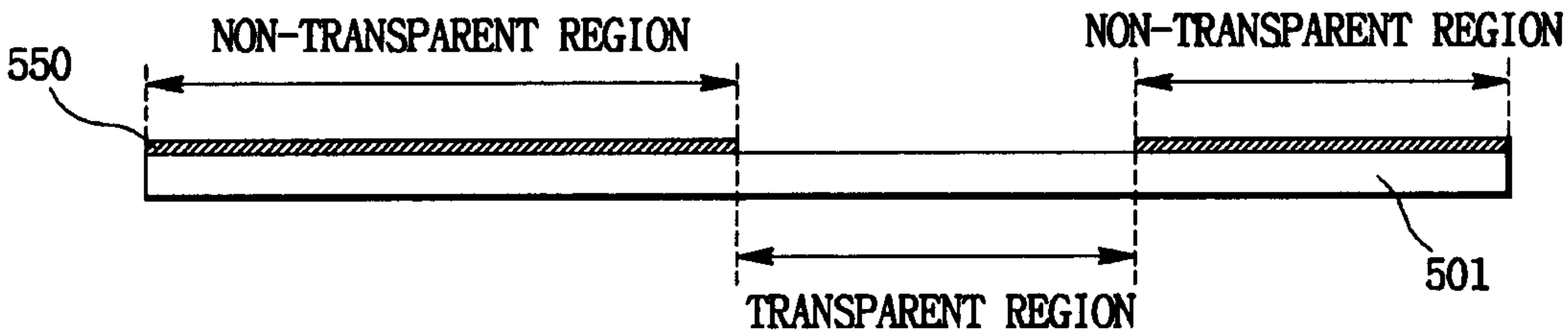

NON-TRANSPARENT REGION
NON-TRANSPARENT REGION
550
501
TRANSPARENT REGION

FIG. 7

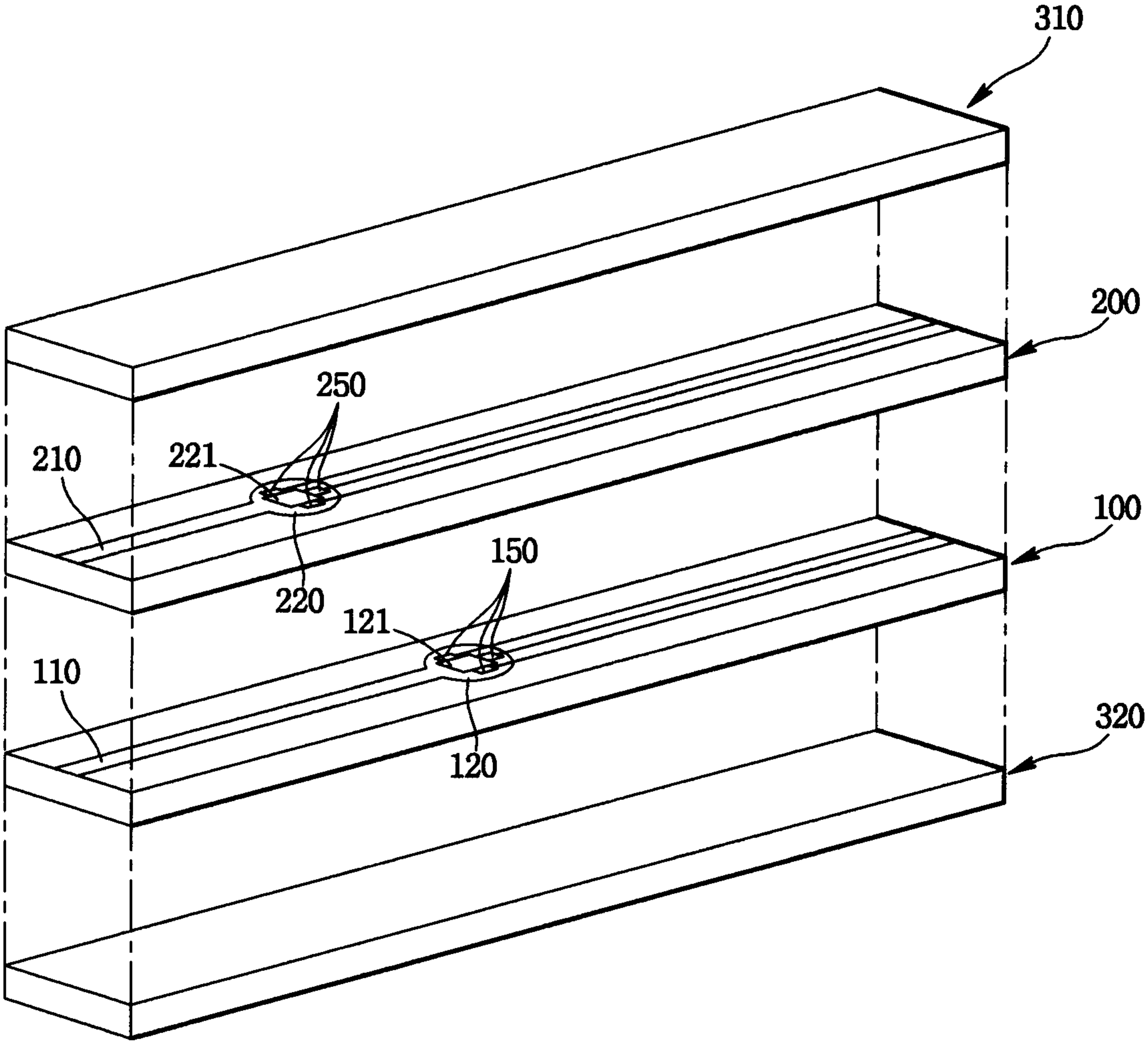


FIG. 8

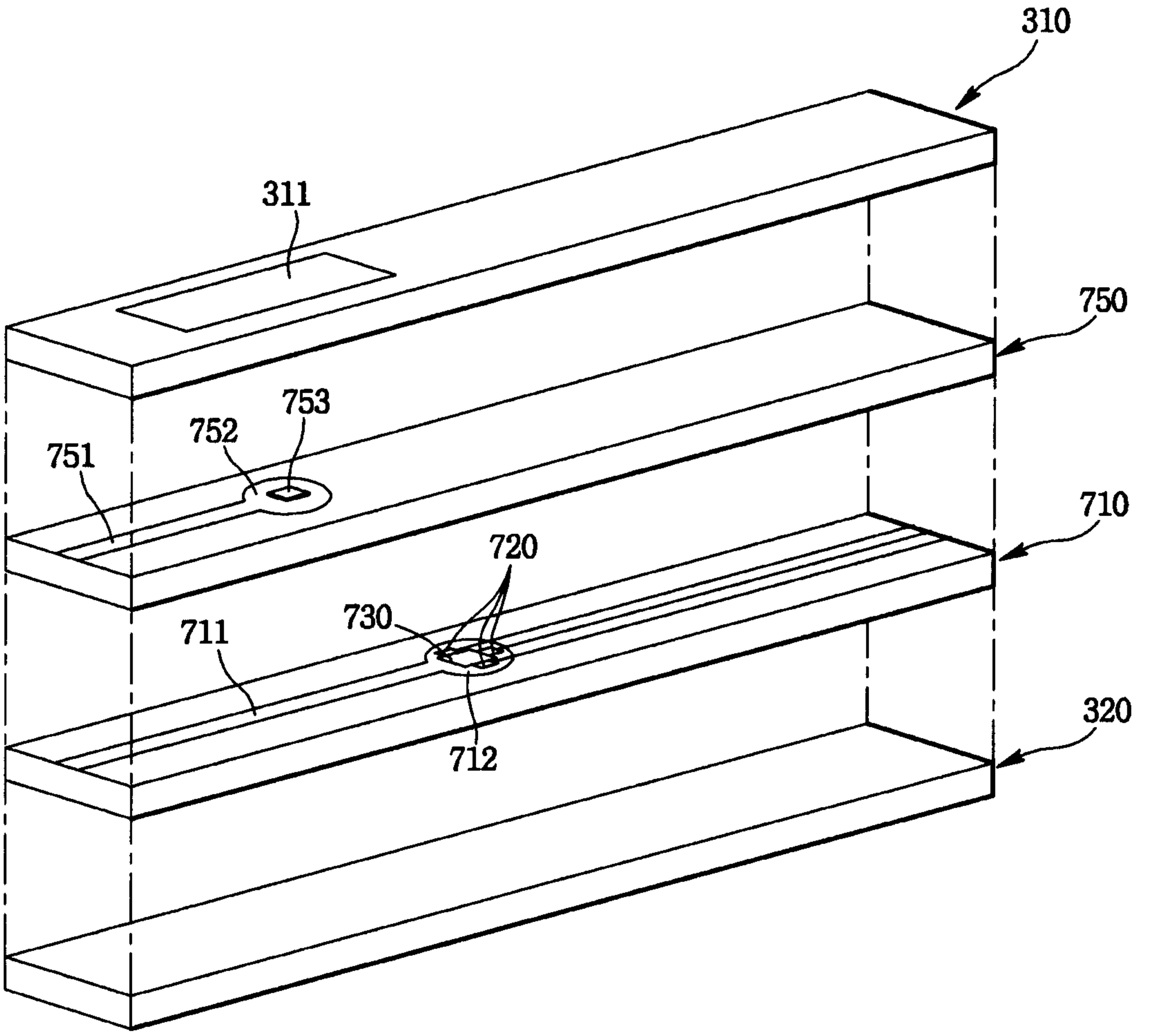


FIG. 9

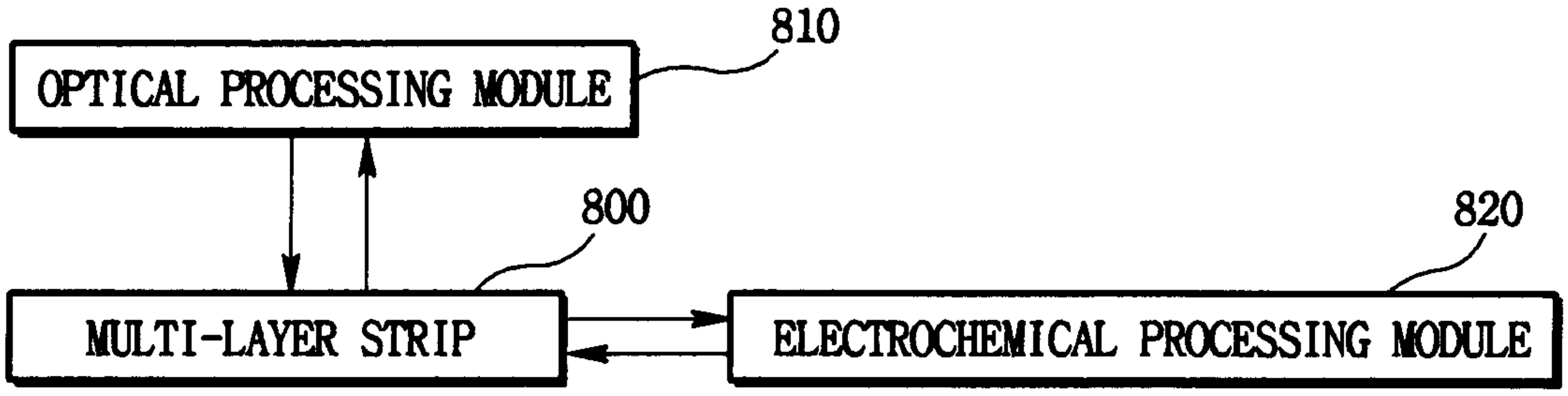

810
OPTICAL PROCESSING MODULE
800
820
MULTI-LAYER STRIP
ELECTROCHEMICAL PROCESSING MODULE

FIG. 10

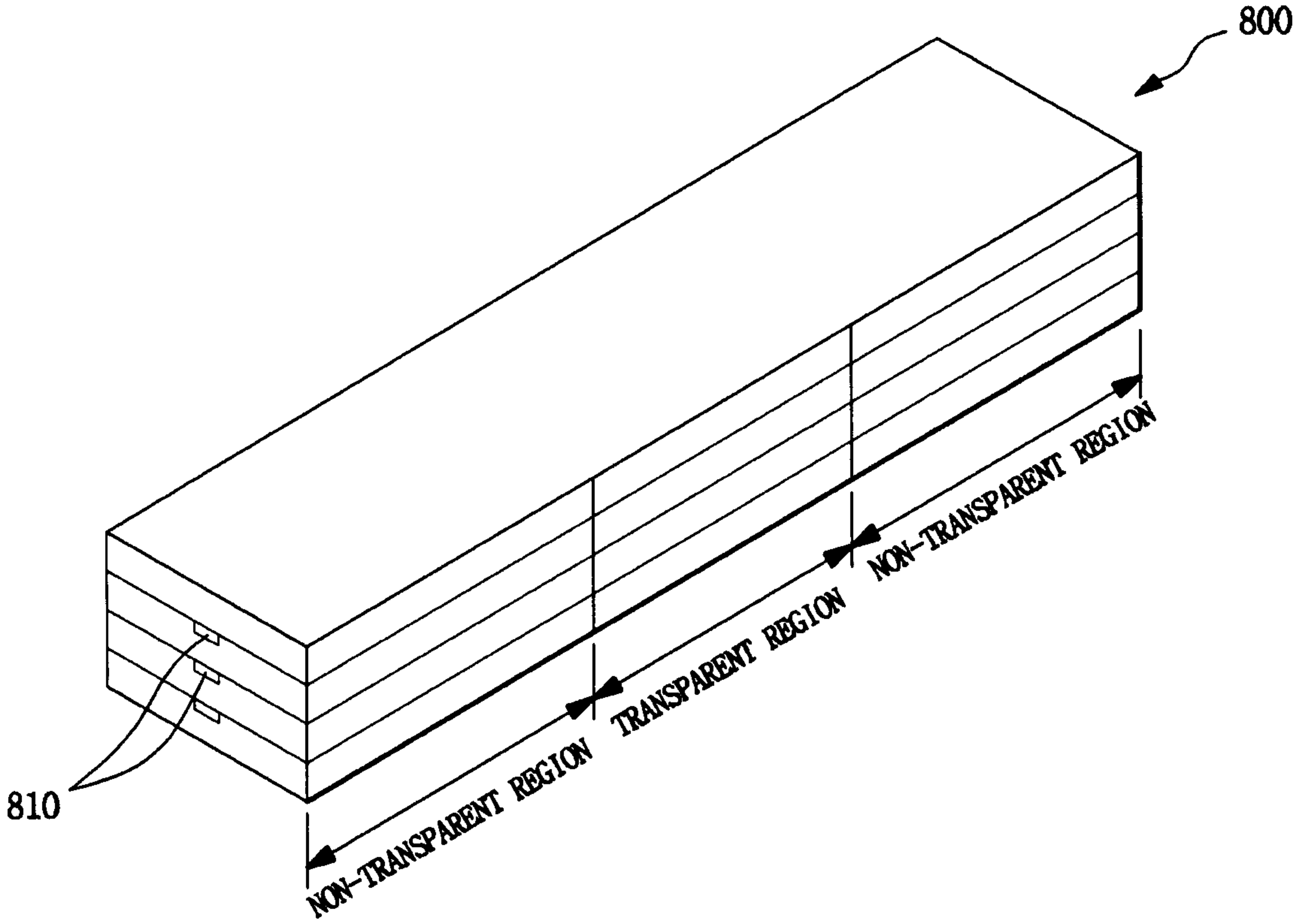
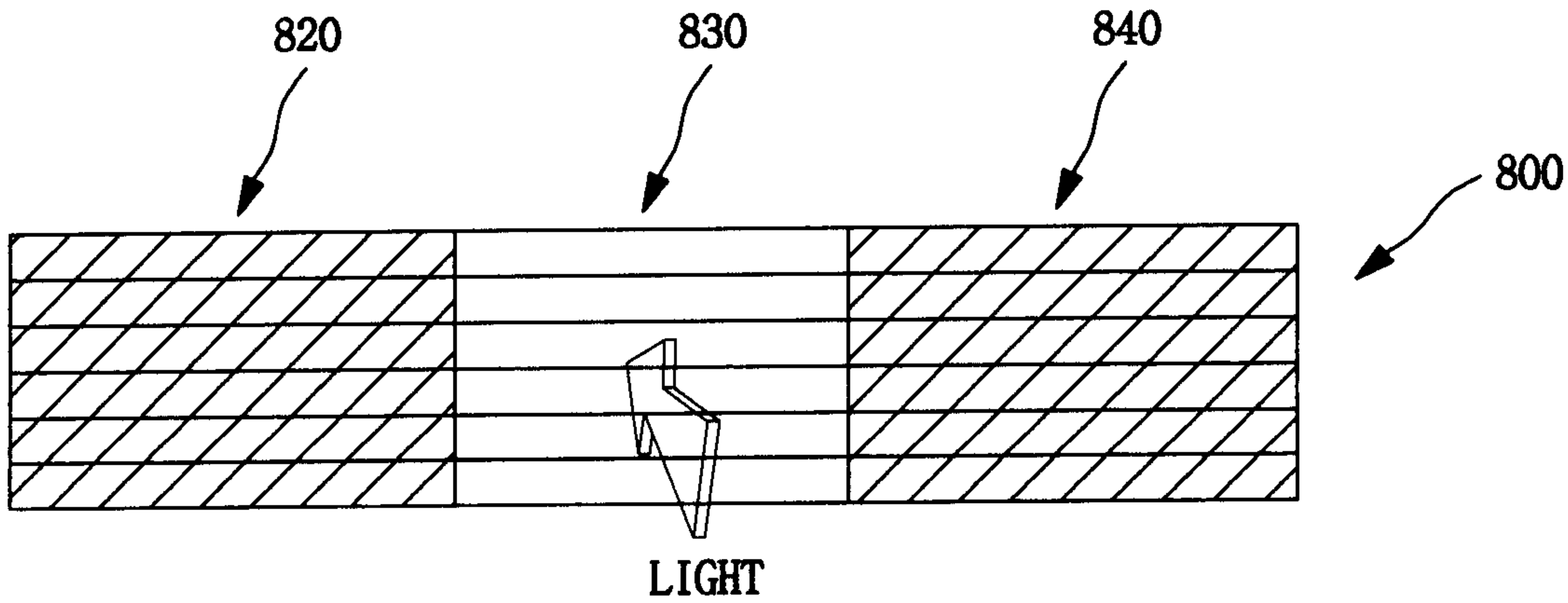
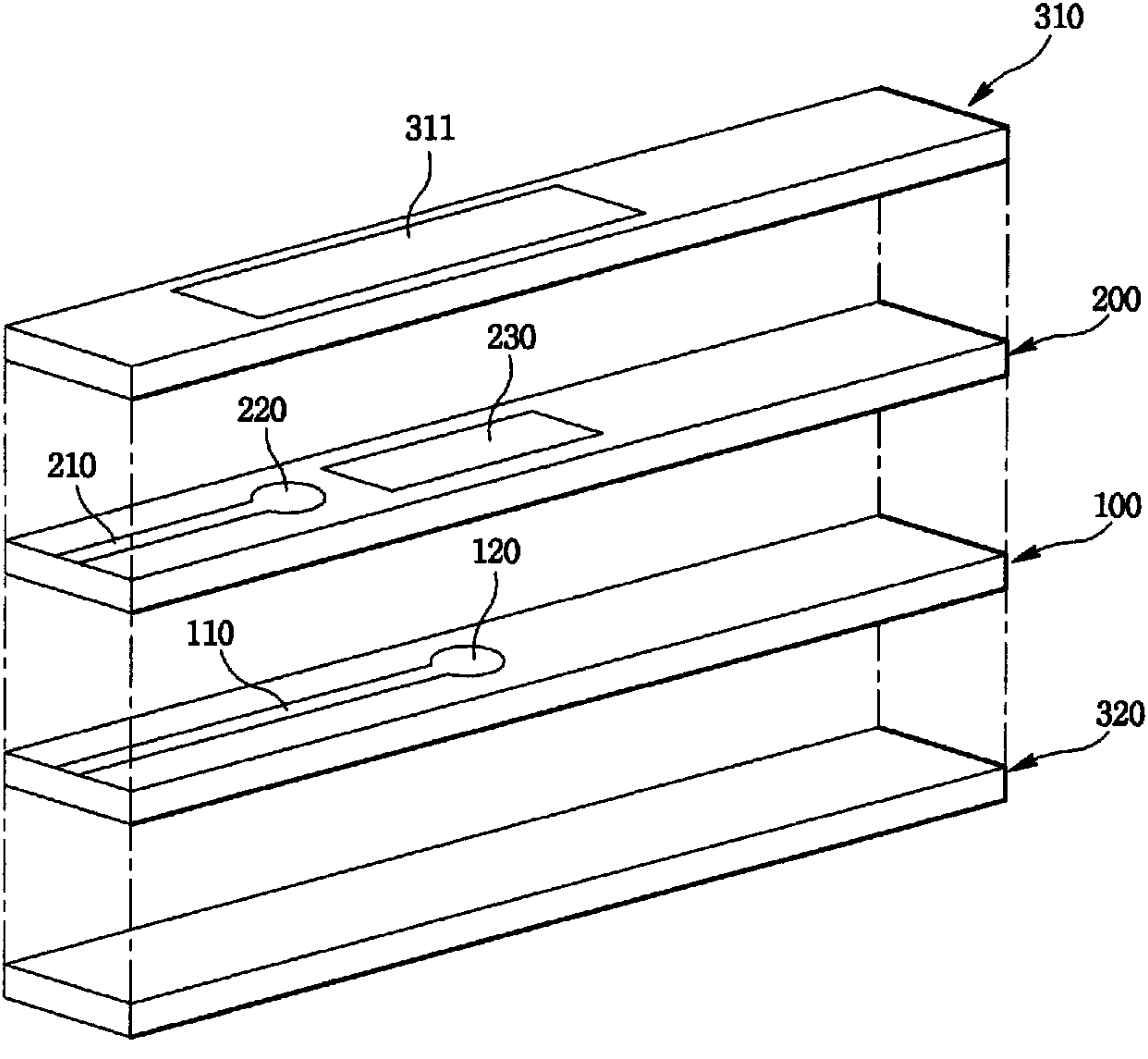

800
810
NON-TRANSPARENT REGION
TRANSPARENT REGION
NON-TRANSPARENT REGION

FIG. 11


820
830
840
800
LIGHT


310
311
200
230
220
210
100
120
110
320