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(54) **SENSOR**

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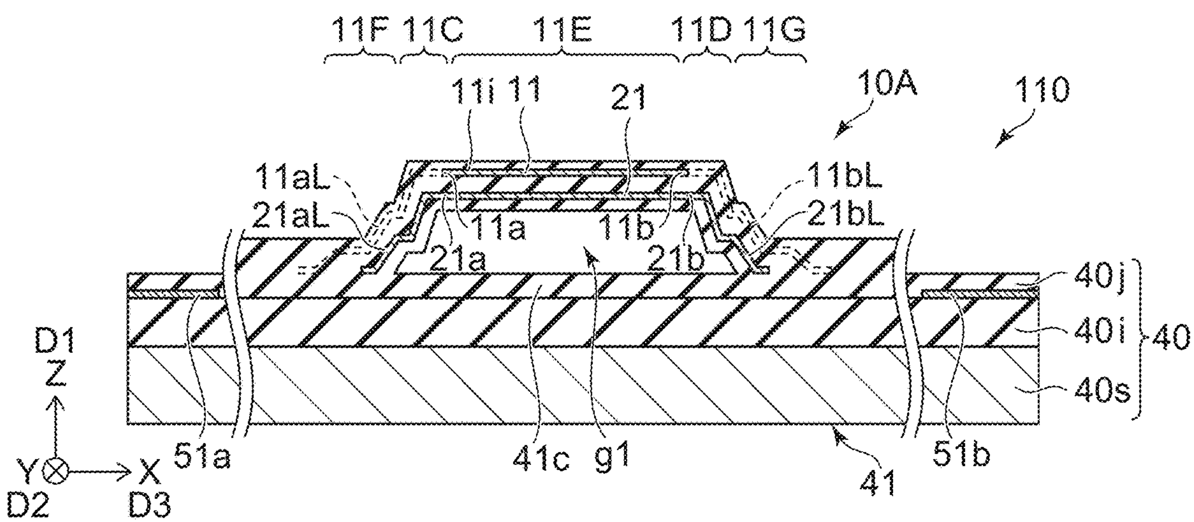
(57) **ABSTRACT**

According to one embodiment, a sensor includes a base, a first detection section, a first conductive layer, and a first conductive layer terminal. The base includes a first base region including a first intermediate region. The first conductive layer is fixed to the base. The first conductive layer includes a first conductive region and a first other conductive region. The first conductive layer terminal is electrically connected to the first conductive layer. The first detection section includes a first fixed portion fixed to the first base region, and a first element supported by the first fixed portion. The first element includes a first resistance member and a first conductive member. A first gap is provided between the first intermediate region and the first element in the first direction.



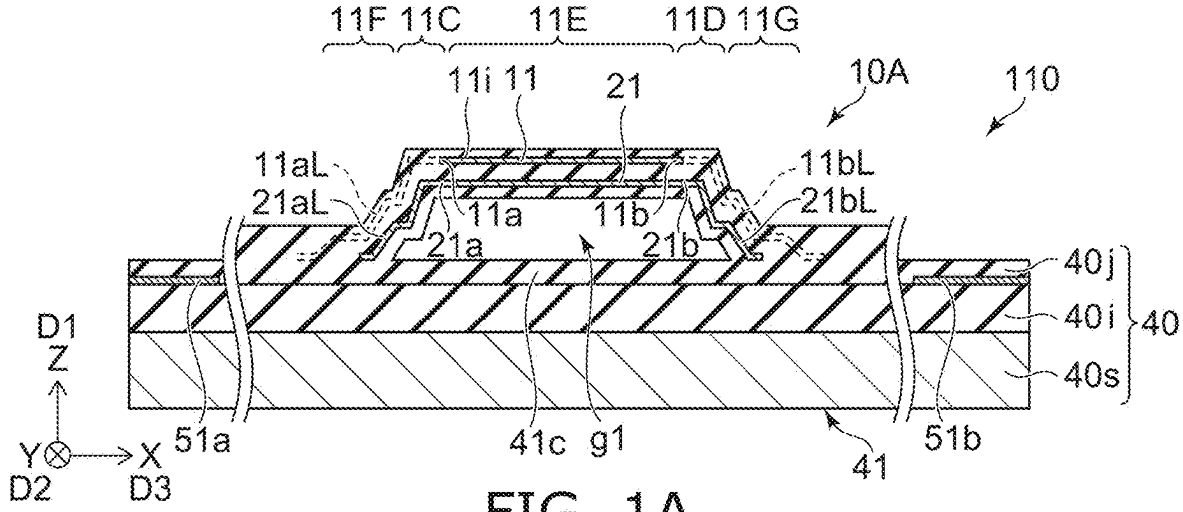


FIG. 1A

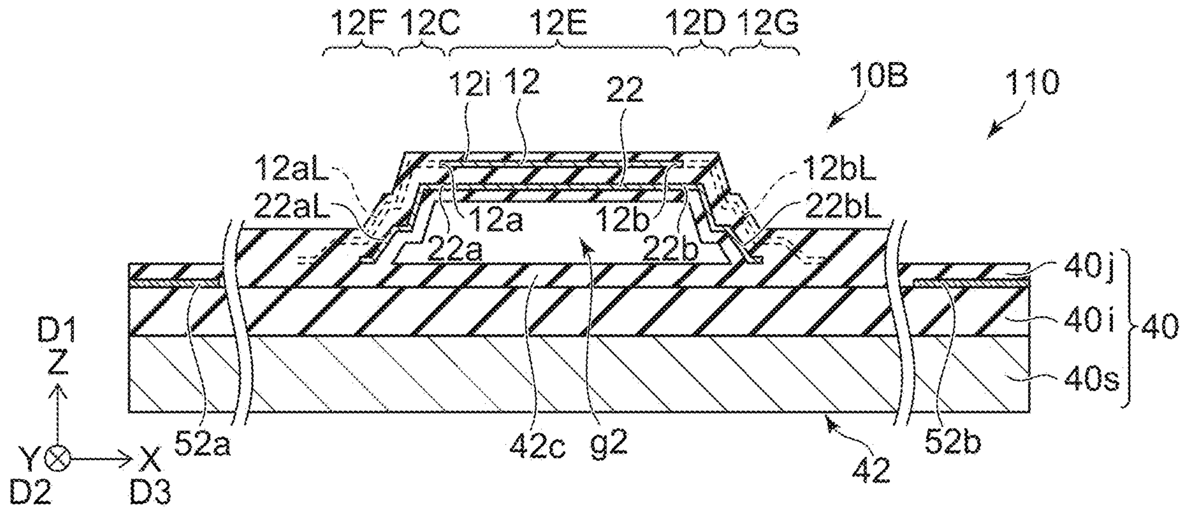


FIG. 1B

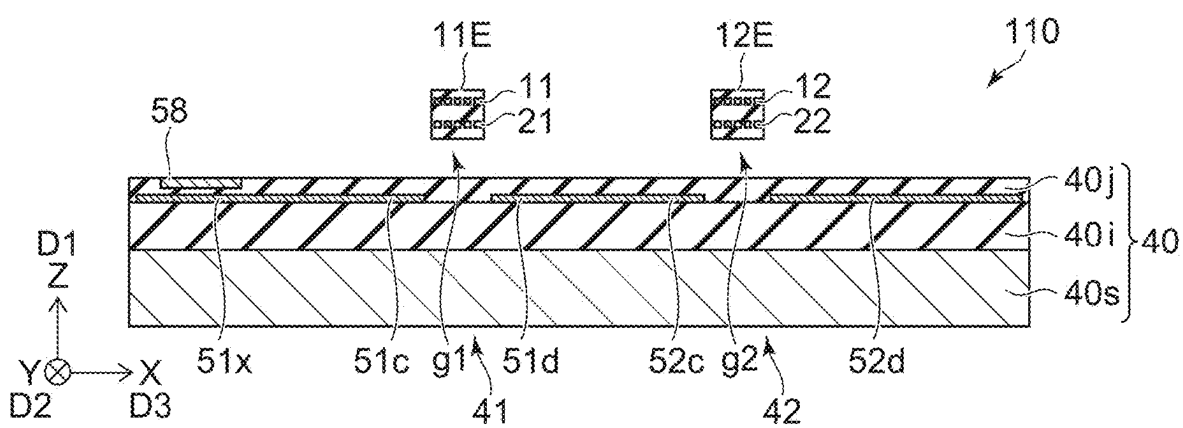


FIG. 1C

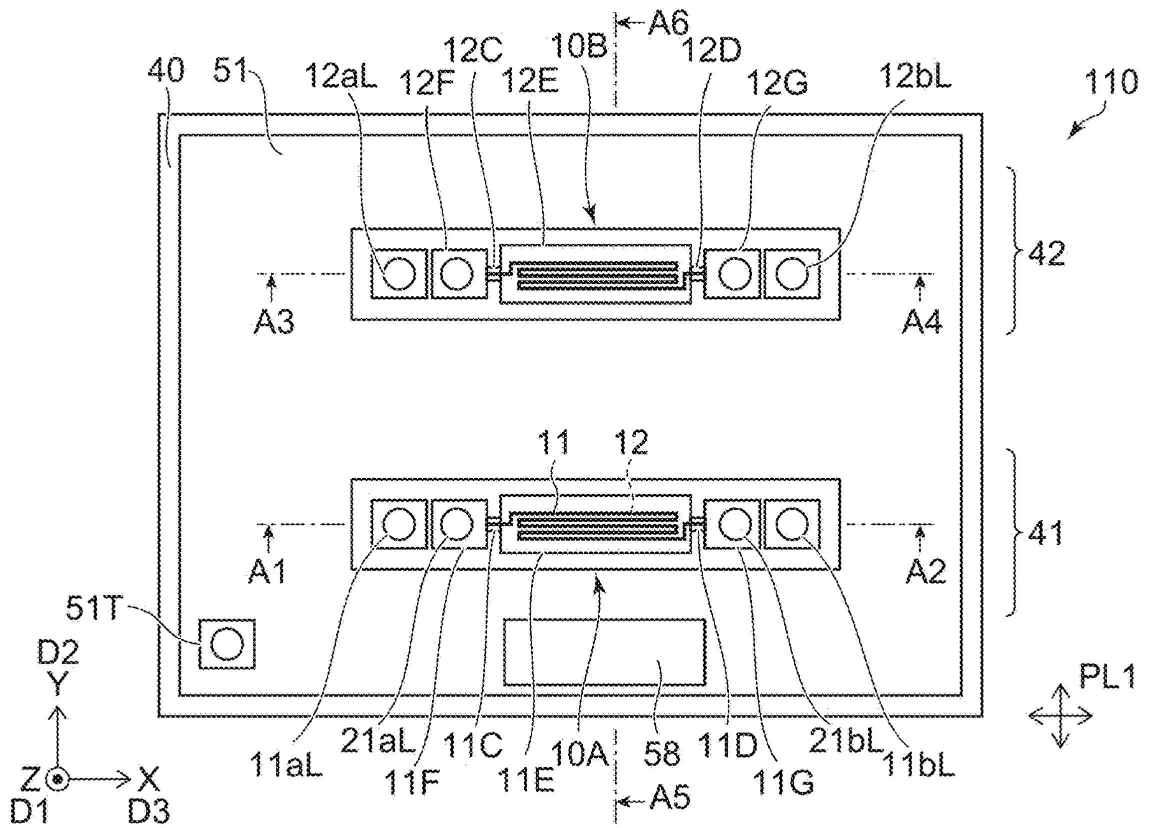

A6
40
51
12aL
12F
12C
10B
12E
12D
12G
12bL
110
42
A3
A4
11
12
41
A1
A2
51T
D2
Y
PL1
11aL
21aL
11C
10A
58
11D
21bL
11bL
11F
11E
11G
A5
Z
X
D1
D3

FIG. 2A

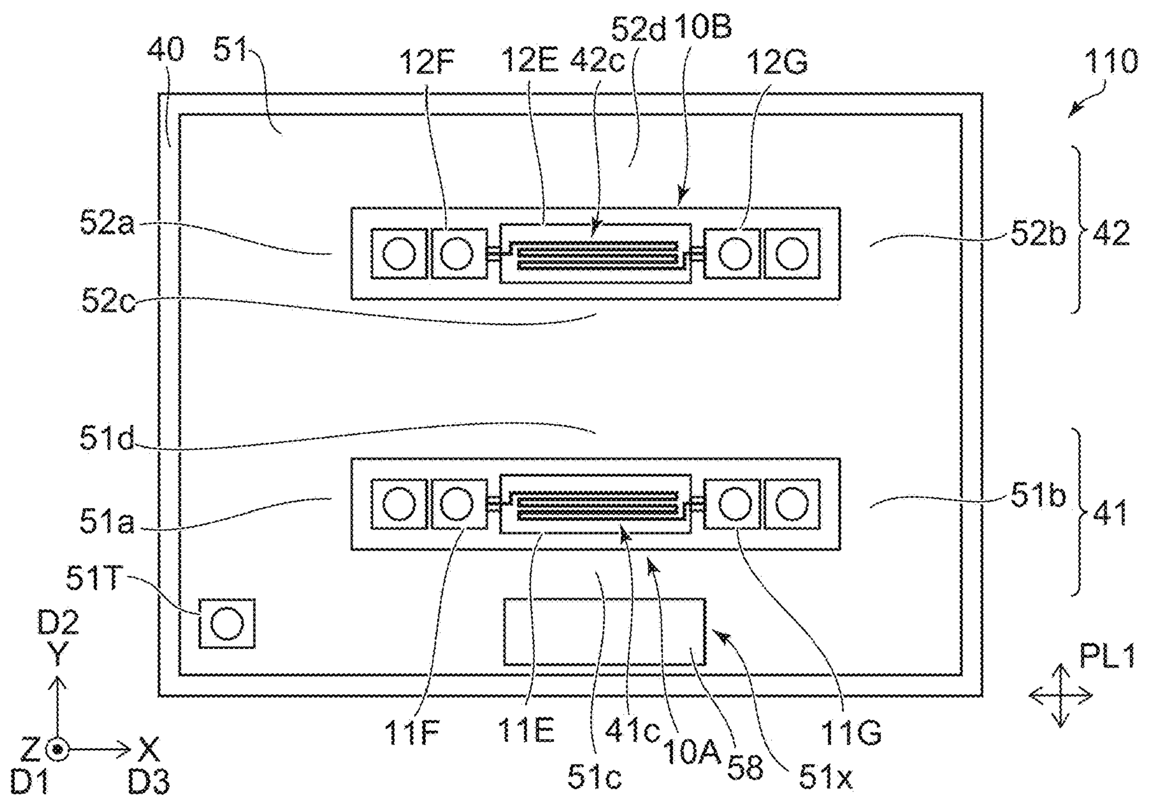

40
51
12F
12E
42c
52d
10B
12G
110
52a
52b
42
52c
51d
51b
51a
41
51T
D2
Y
PL1
11F
11E
41c
10A
58
11G
51c
51x
Z
X
D1
D3

FIG. 2B

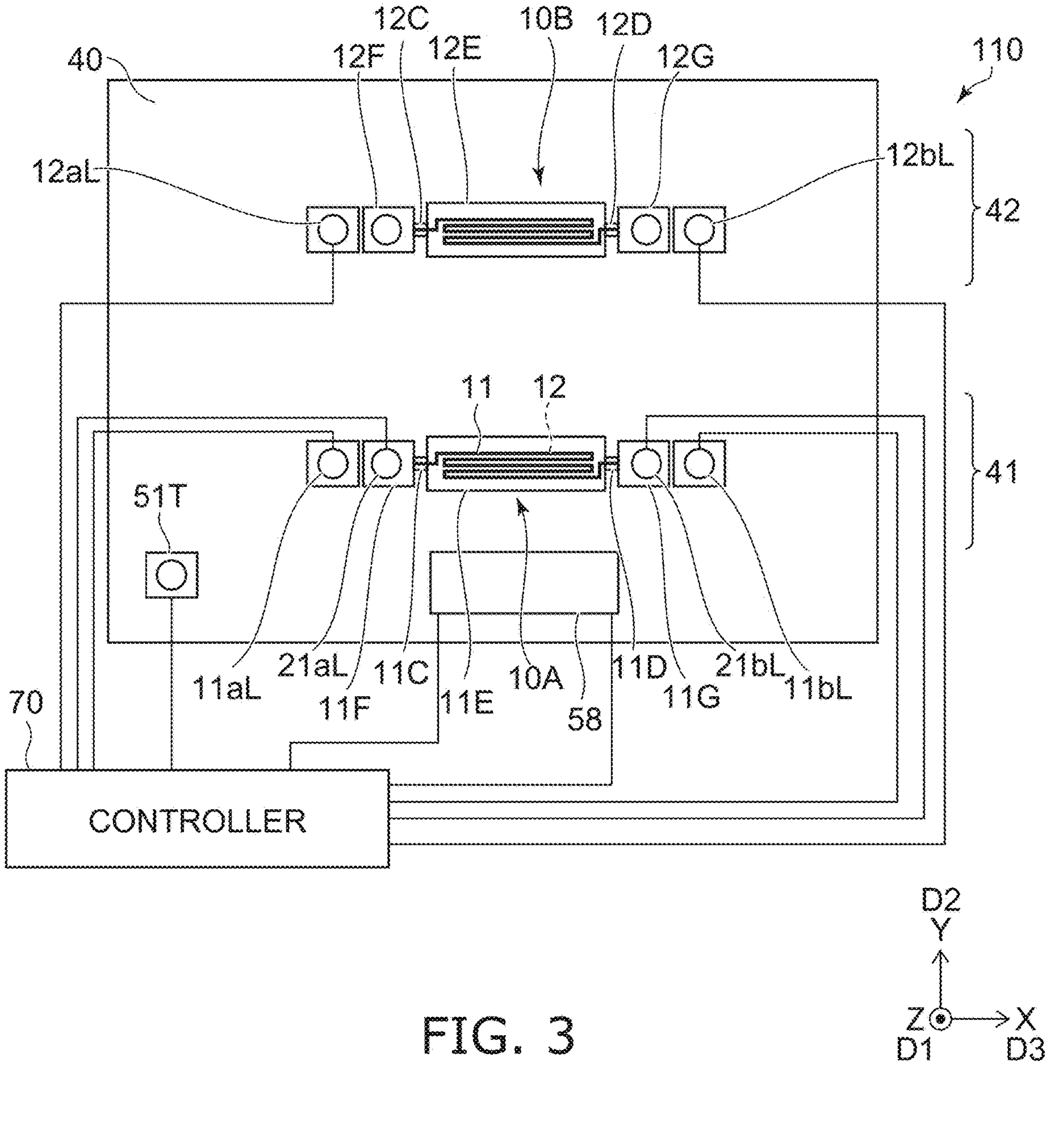

12C
10B
12D
40
12F
12E
12G
110
12aL
12bL
42
11
12
41
51T
11aL
21aL
11C
11F
11E
10A
58
11D
11G
21bL
11bL
70
CONTROLLER
D2
Y
Z
X
D1
D3

FIG. 3

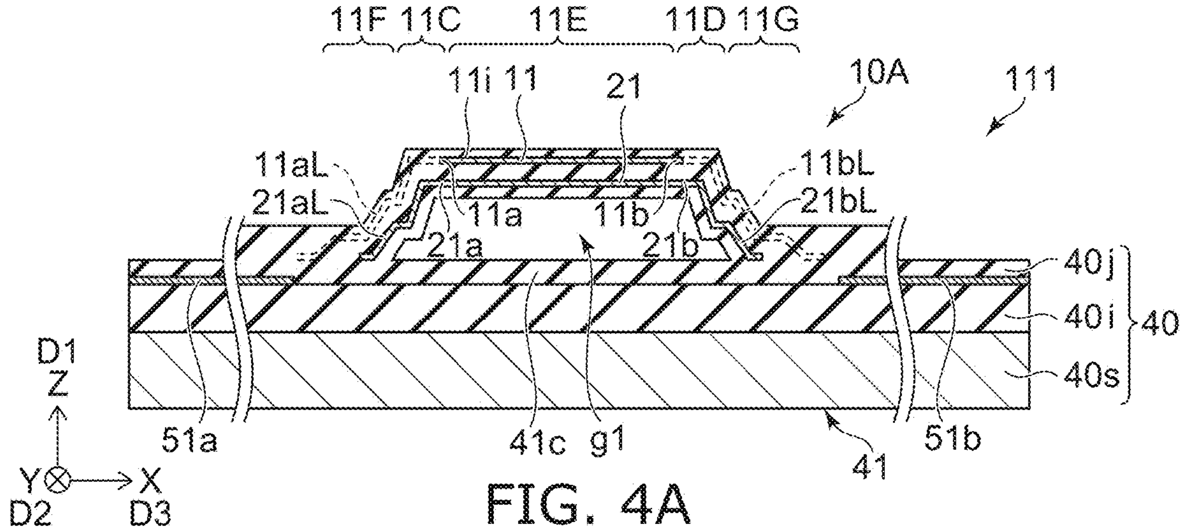


FIG. 4A

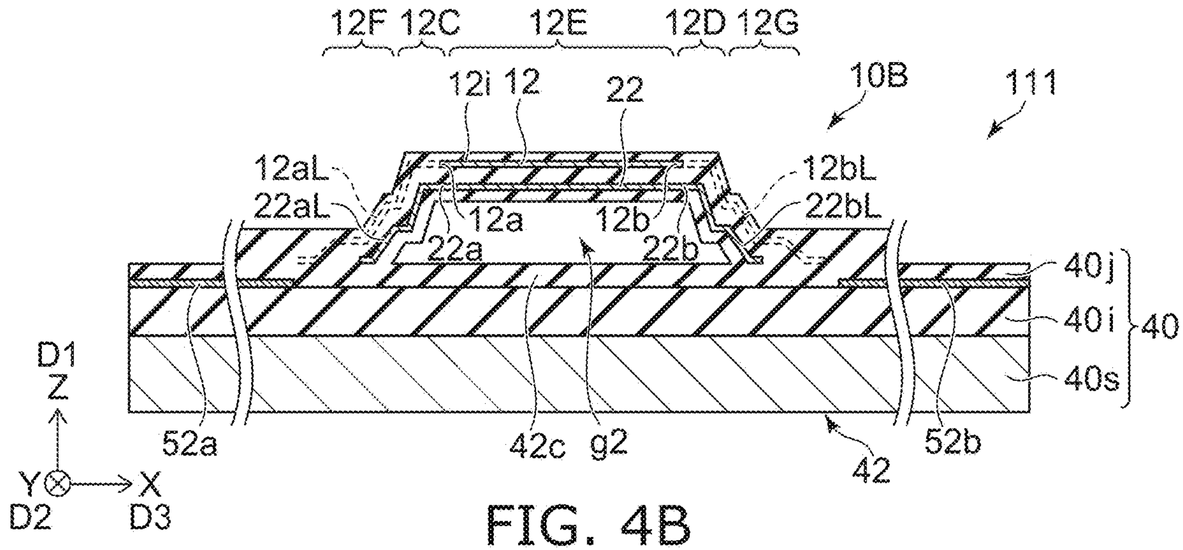


FIG. 4B

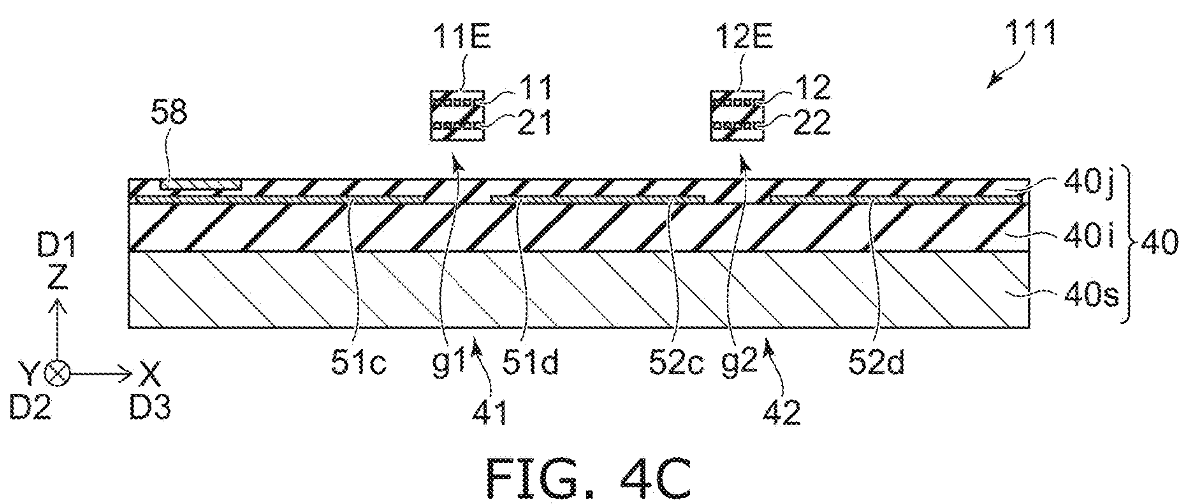


FIG. 4C

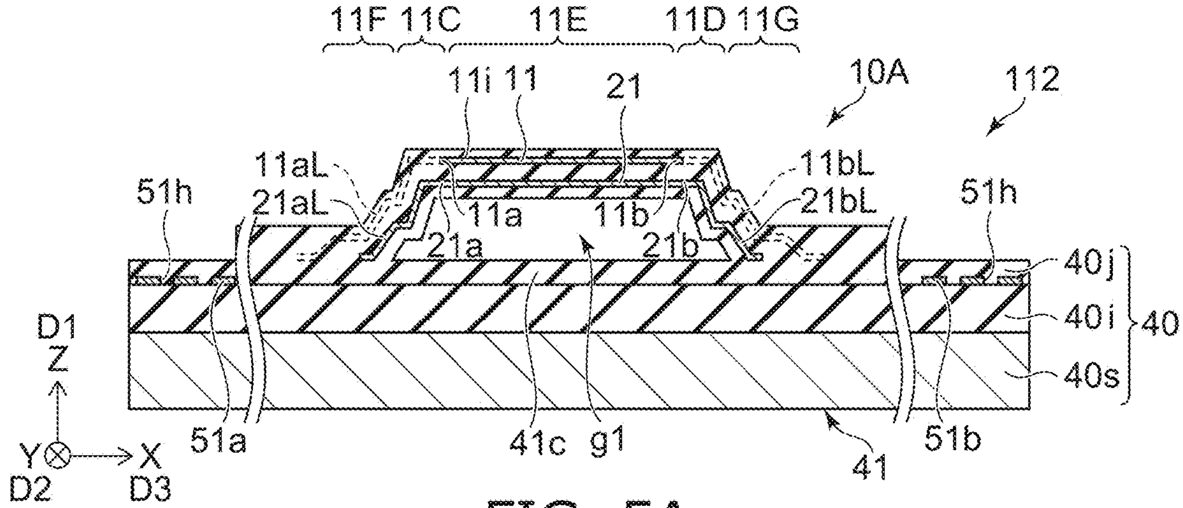


FIG. 5A

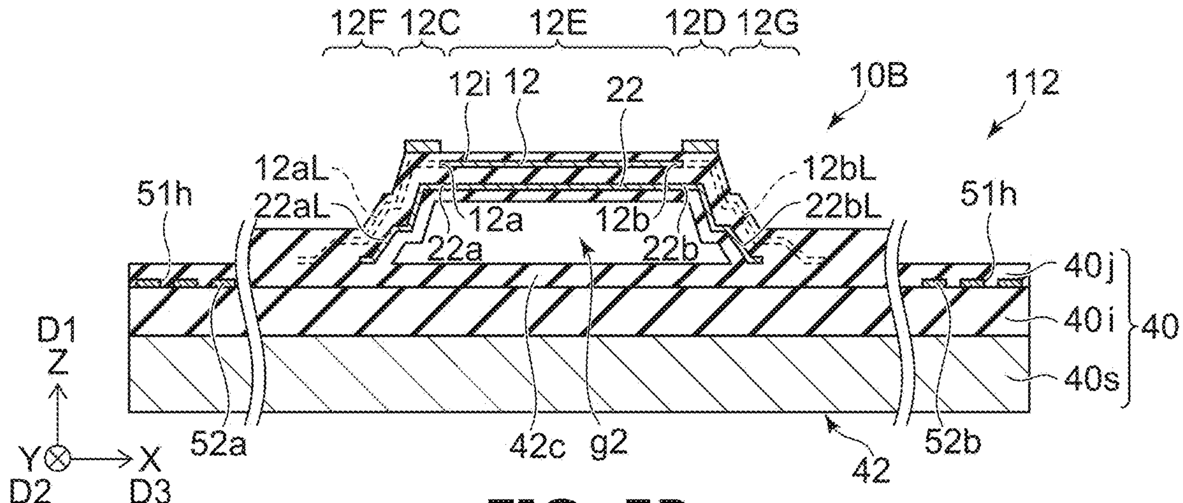


FIG. 5B

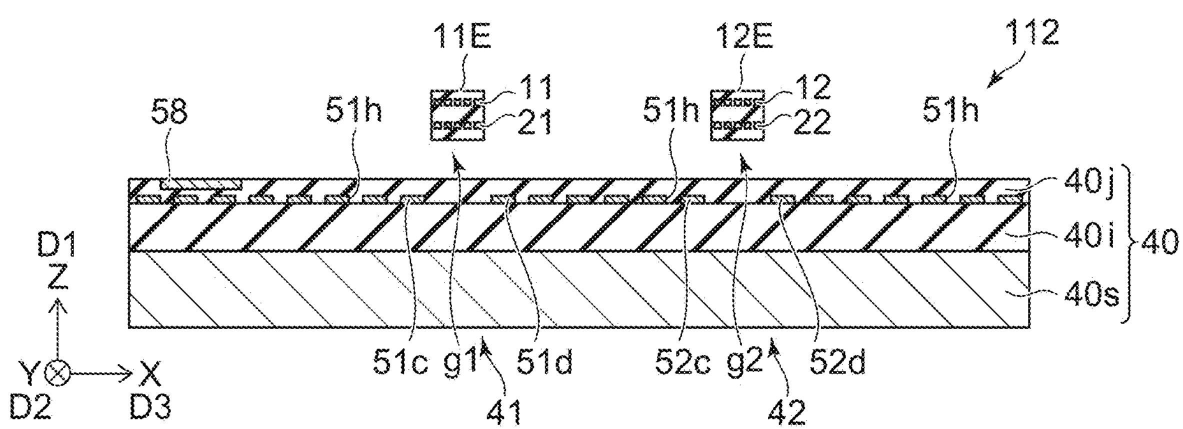


FIG. 5C

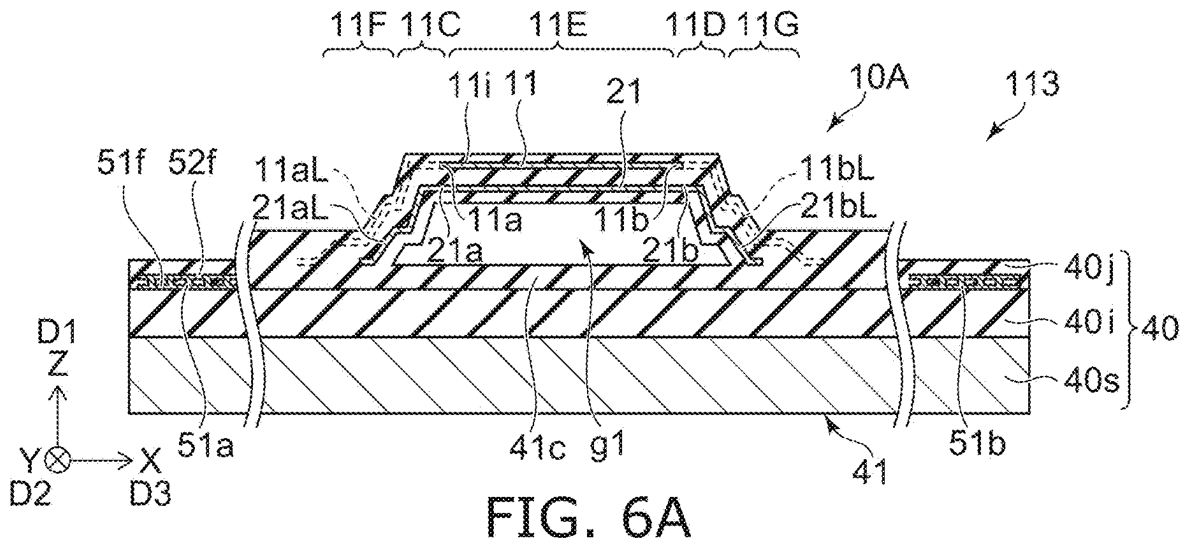


FIG. 6A

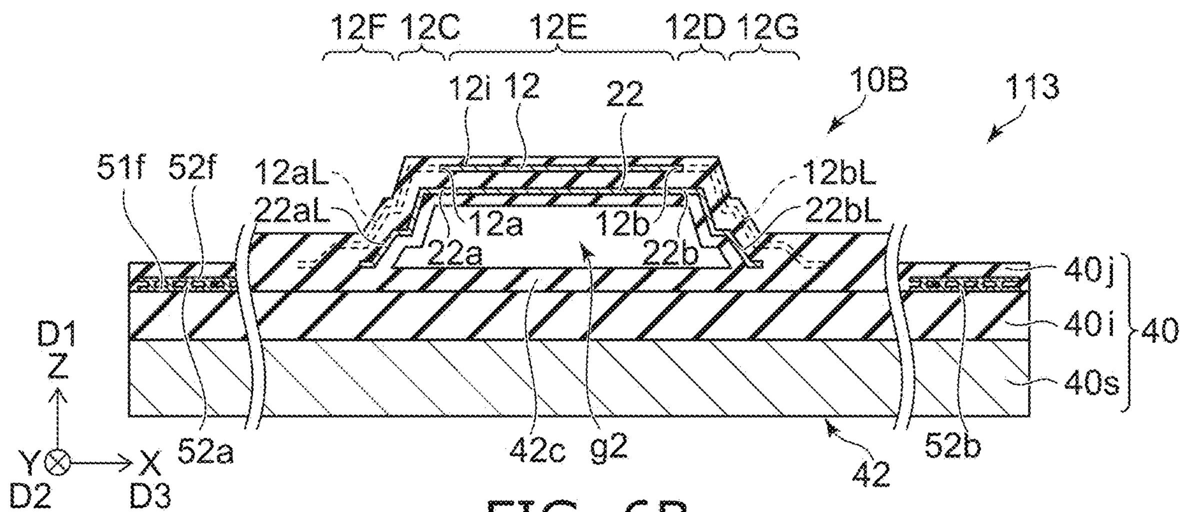


FIG. 6B

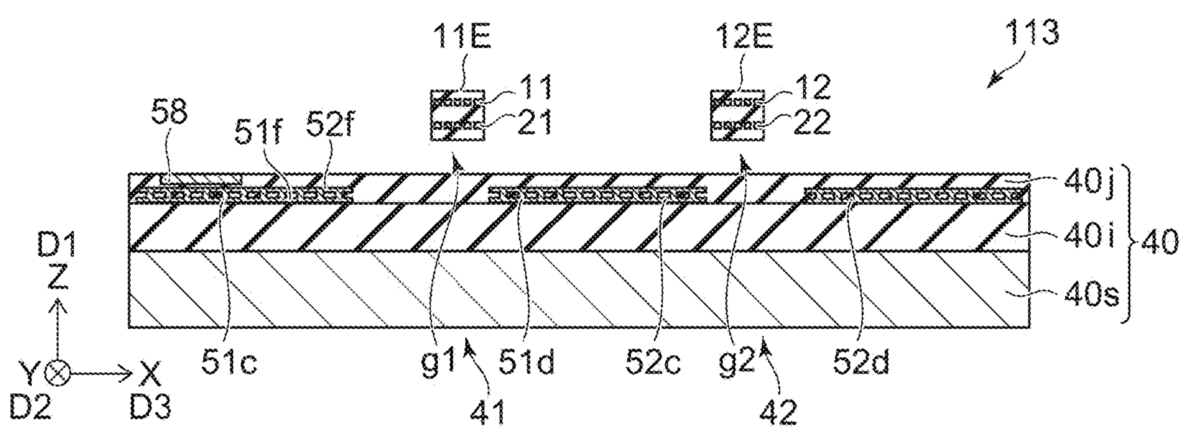


FIG. 6C

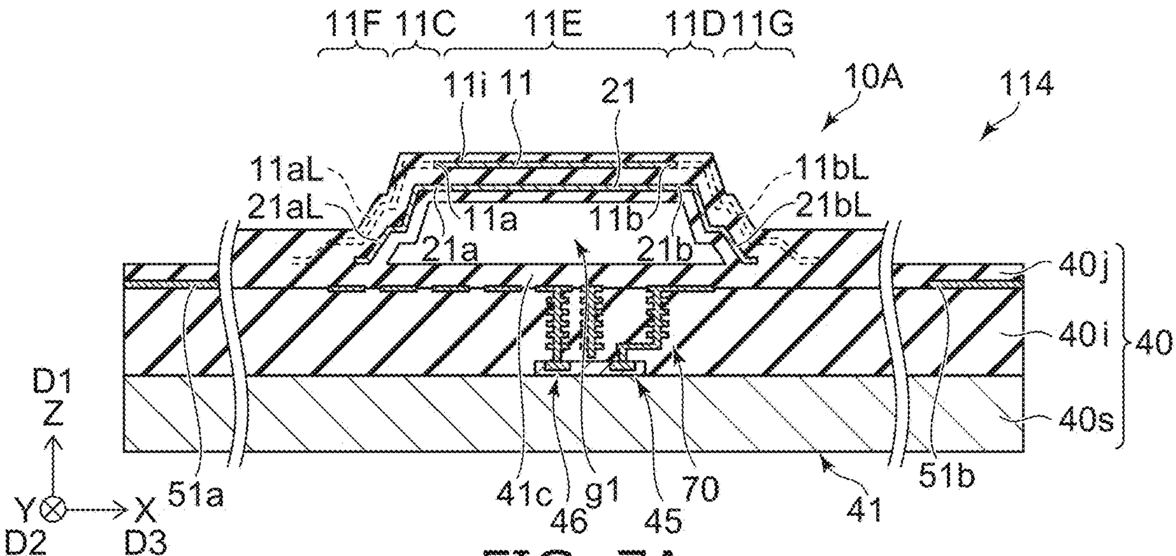


FIG. 7A

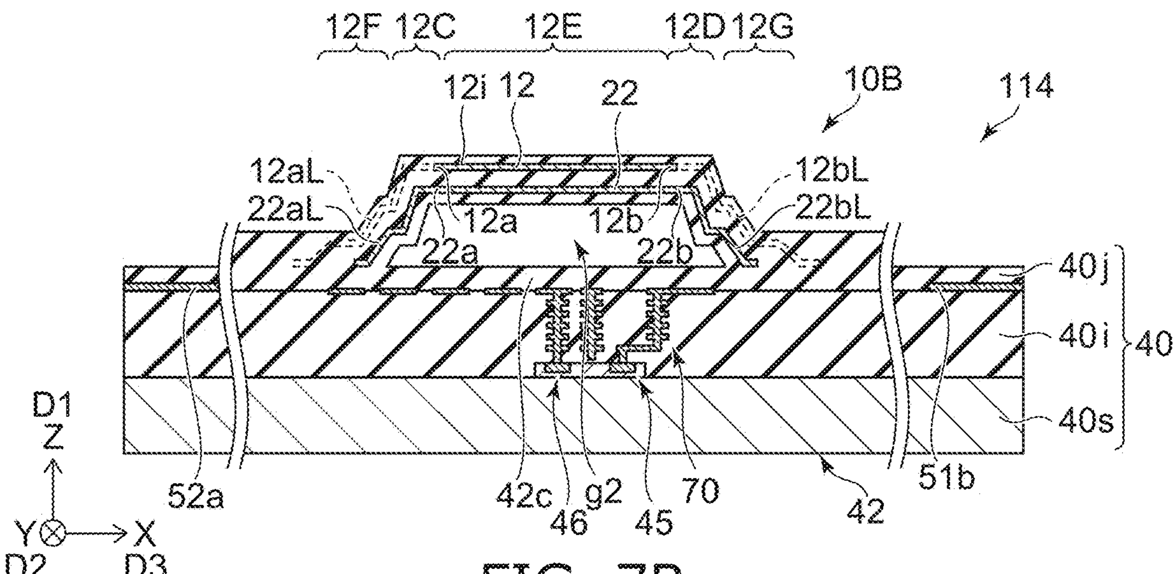


FIG. 7B

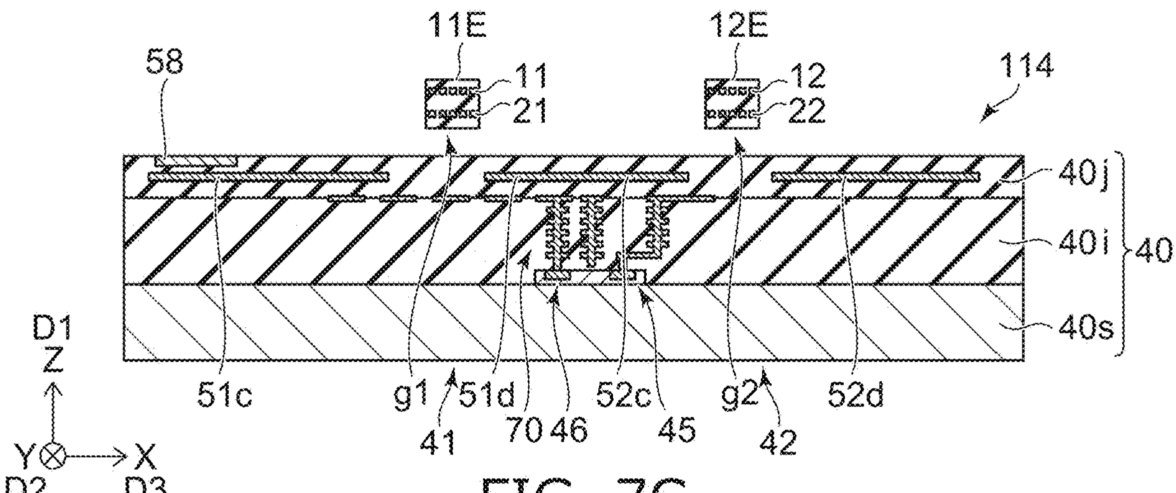


FIG. 7C

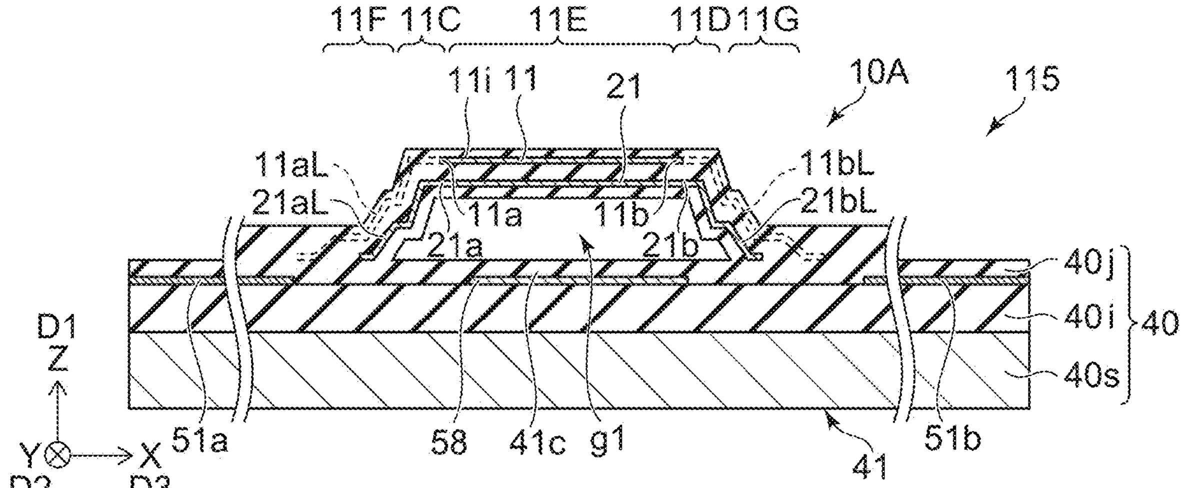


FIG. 8A

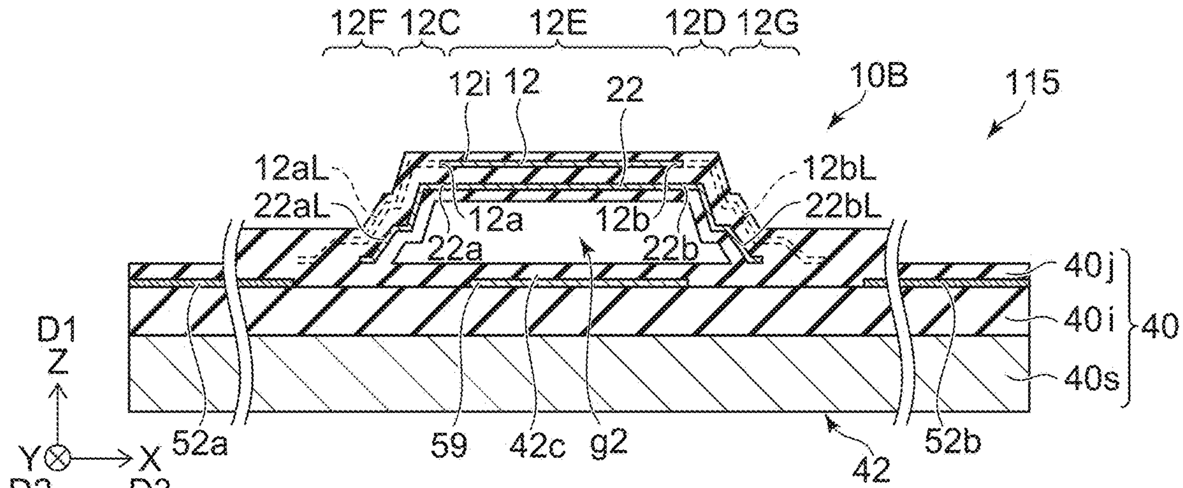


FIG. 8B

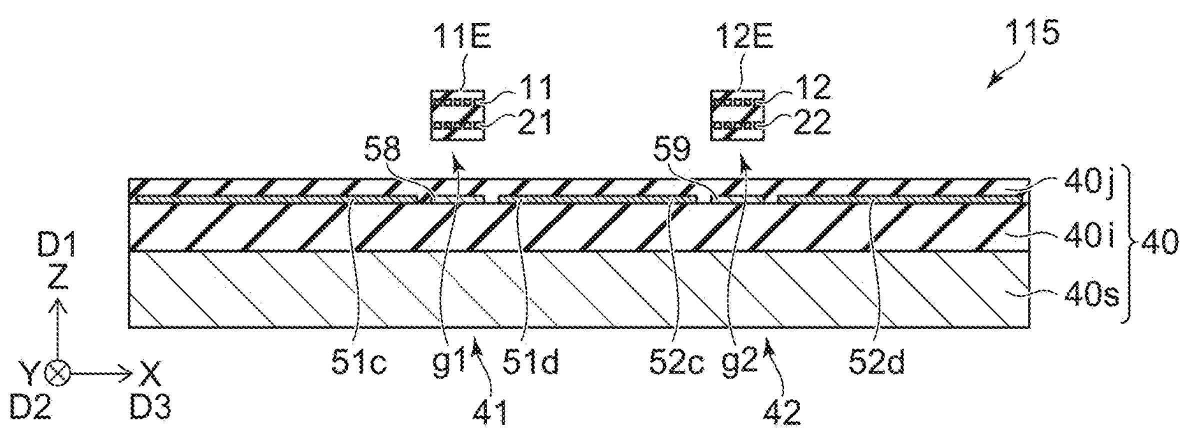


FIG. 8C

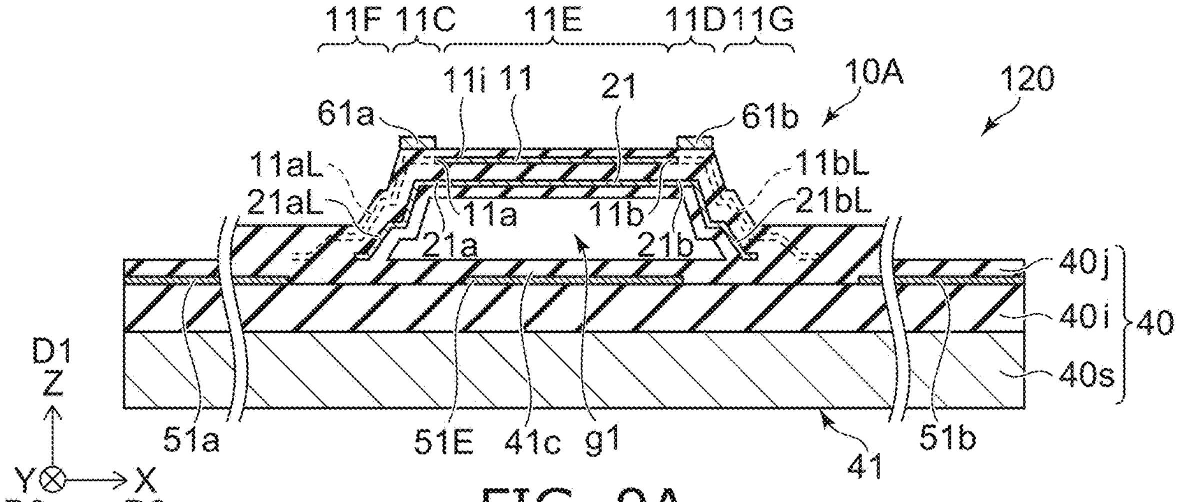


FIG. 9A

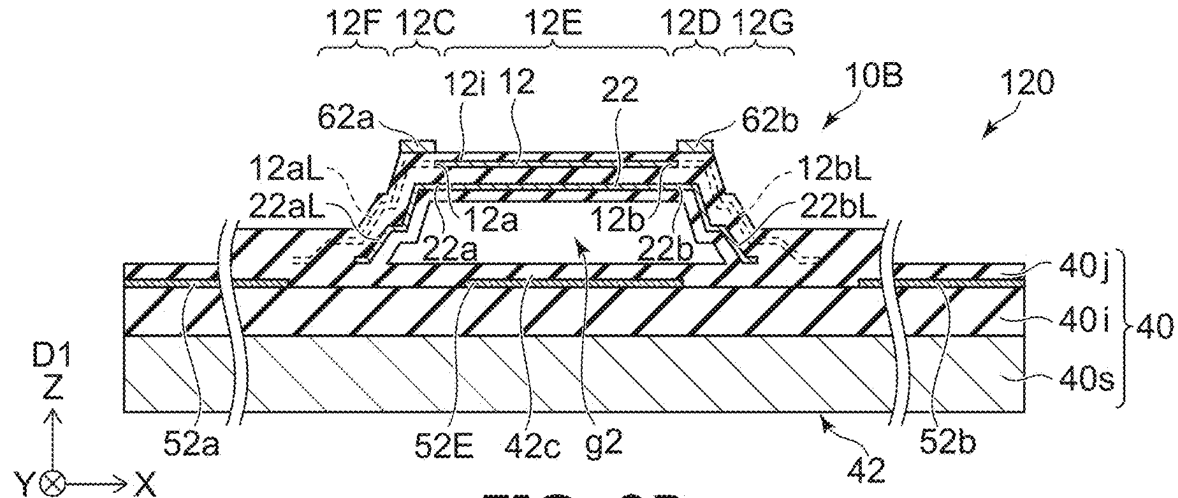


FIG. 9B

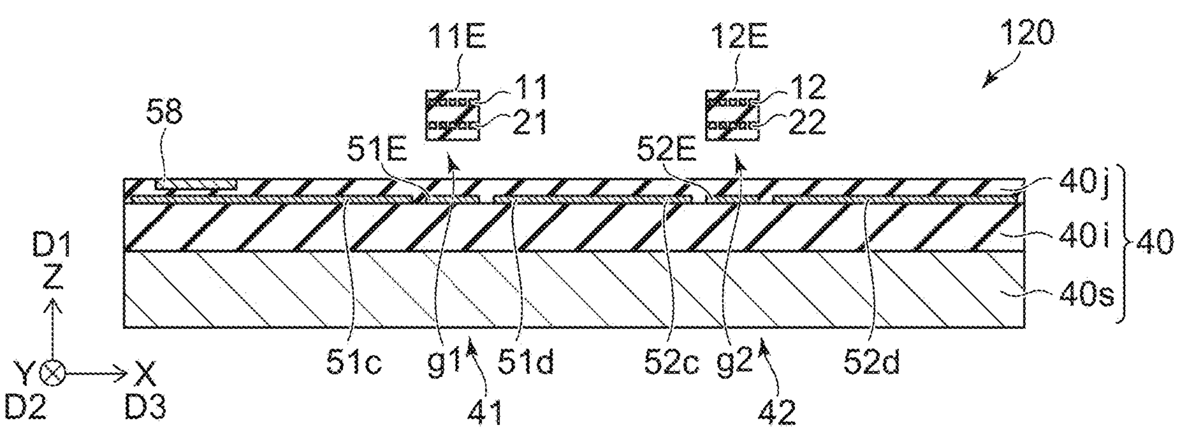


FIG. 9C

SENSOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2024-022503, filed on Feb. 19, 2024; the entire contents of which are incorporated herein by reference.

FIELD

[0002] Embodiments described herein relate generally to a sensor.

BACKGROUND

[0003] For example, there are sensors using MEMS (Micro Electro Mechanical Systems) elements. Stable detection is desired in sensors.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIGS. **1**A to **1**C are schematic cross-sectional views illustrating a sensor according to a first embodiment;

[0005] FIGS. **2**A and **2**B are schematic plan views illustrating the sensor according to the first embodiment;

[0006] FIG. **3** is a schematic plan view illustrating the sensor according to the first embodiment;

[0007] FIGS. **4**A to **4**C are schematic cross-sectional views illustrating a sensor according to the first embodiment;

[0008] FIGS. **5**A to **5**C are schematic cross-sectional views illustrating a sensor according to the first embodiment;

[0009] FIGS. **6**A to **6**C are schematic cross-sectional views illustrating a sensor according to the first embodiment;

[0010] FIGS. **7**A to **7**C are schematic cross-sectional views illustrating a sensor according to the first embodiment;

[0011] FIGS. **8**A to **8**C are schematic cross-sectional views illustrating a sensor according to the first embodiment; and

[0012] FIGS. **9**A to **9**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

DETAILED DESCRIPTION

[0013] According to one embodiment, a sensor includes a base, a first detection section, a first conductive layer, and a first conductive layer terminal. The base includes a first base region including a first intermediate region. The first conductive layer is fixed to the base. The first conductive layer includes a first conductive region and a first other conductive region. The first conductive layer terminal is electrically connected to the first conductive layer. The first detection section includes a first fixed portion fixed to the first base region, and a first element supported by the first fixed portion. The first element includes a first resistance member and a first conductive member. A position of the first intermediate region in a second direction crossing a first direction from the first base region to the first fixed portion is between a position of the first conductive region in the second direction and a position of the first other conductive region in the second direction. A first gap is provided between the first intermediate region and the first element in the first direction.

[0014] Various embodiments are described below with reference to the accompanying drawings.

[0015] The drawings are schematic and conceptual; and the relationships between the thickness and width of portions, the proportions of sizes among portions, etc., are not necessarily the same as the actual values. The dimensions and proportions may be illustrated differently among drawings, even for identical portions.

[0016] In the specification and drawings, components similar to those described previously or illustrated in an antecedent drawing are marked with like reference numerals, and a detailed description is omitted as appropriate.

First Embodiment

[0017] FIGS. **1**A to **1**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0018] FIGS. **2**A, **2**B, and **3** are schematic plan views illustrating the sensor according to the first embodiment.

[0019] FIG. **1**A is a cross-sectional view taken along the line A**1**-A**2** in FIG. **2**A. FIG. **1**B is a sectional view taken along the line A**3**-A**4** in FIG. **2**A. FIG. **1**C is a sectional view taken along the line A**5**-A**6** in FIG. **2**A.

[0020] As shown in these figures, a sensor **110** according to the embodiment includes a base **40**, a first detection section **10**A, and a first conductive layer **51**. The sensor **110** may further include a first conductive layer terminal **51**T. As described later, the sensor **110** may further include a second detection section **10**B and the like.

[0021] The base **40** includes a first base region **41**. The first base region **41** includes a first intermediate region **41***c*. The base **40** may include, for example, a substrate **40***s*, a first insulating layer **40***i*, and a second insulating layer **40***j*. The substrate **40***s* may be, for example, a semiconductor substrate. The substrate **40***s* may include, for example, a silicon substrate. The first insulating layer **40***i* is provided on the substrate **40***s*. The second insulating layer **40***j* is provided on the first insulating layer **40***i*. The first insulating layer **40***i* may include silicon oxide, for example. The second insulating layer **40***j* may include silicon nitride, for example.

[0022] The first conductive layer **51** is fixed to the base **40**. In this example, the first conductive layer **51** is provided between the first insulating layer **40***i* and the second insulating layer **40***j*. The first conductive layer **51** includes a first conductive region **51***c* and a first other conductive region **51***d*. The first conductive layer terminal **51**T is electrically connected to the first conductive layer **51**.

[0023] The first detection section **10**A includes a first fixed portion **11**F fixed to the first base region **41** and a first element **11**E supported by the first fixed portion **11**F. The first element **11**E includes a first resistance member **11** and a first conductive member **21**.

[0024] A first direction D**1** from the first base region **41** to the first fixed portion **11**F is defined as a Z-axis direction. One direction perpendicular to the Z-axis direction is defined as a Y-axis direction. A direction perpendicular to the Z-axis direction and the Y-axis direction is defined as an X-axis direction.

[0025] As shown in FIG. **2**B, a position of the first intermediate region **41***c* in a second direction D**2** crossing the first direction D**1** is between a position of the first conductive region **51***c* in the second direction D**2** and a position of the first other conductive region **51***d* in the second direction D**2**. The second direction D**2** may be, for example, the Y-axis direction.

[0026] As shown in FIG. **1**A, a first gap g**1** is provided between the first intermediate region **41***c* and the first element **11**E in the first direction D**1**.

[0027] As shown in FIG. **1**A, the first resistance member **11** includes a first resistance portion **11***a* and a first other resistance portion **11***b*. The first conductive member **21** includes a first conductive portion **21***a* and a first other conductive portion **21***b*.

[0028] In the embodiment, a first power is supplied between the first conductive portion **21***a* and the first other conductive portion **21***b*. A first electrical resistance between the first resistance portion **11***a* and the first other resistance portion **11***b* is detected. As shown in FIG. **3**, a controller **70** may be provided in the sensor **110**. The controller **70** may be configured to supply the first power. The controller **70** may be configured to detect the first electrical resistance.

[0029] The first electrical resistance changes depending on a detection target existing in a space around the first element **11**E. For example, by supplying the first power to the first conductive member **21** as described above, the temperature of the first element **11**E increases. The first power may be supplied in a pulsed manner, for example. After the temperature of the first element **11**E increases due to the first electric power, the temperature of the first element **11**E decreases toward the original temperature. The heat of the first element **11**E is radiated through the detection target existing around the first element **11**E. Therefore, the temperature of the first element **11**E depends on the state of the detection target existing around the first element **11**E. The first electrical resistance of the first element **11**E changes depending on the temperature of the first element **11**E. By detecting the first electrical resistance, the state of the detection target can be detected. The detection target is, for example, gas. For example, the state of the detection target includes the type and concentration of the detection target (gas).

[0030] In the embodiment, the first conductive layer **51** is provided. The first conductive layer **51** is provided on the base **40** having a large heat capacity. The first conductive layer **51** functions as a heat homogenization layer. Thereby, for example, the temperature change characteristics of the first element **11**E can be made less susceptible to the influence of the ambient temperature. For example, stable detection becomes possible. For example, highly accurate detection becomes possible. According to the embodiment, a sensor capable of highly accurate detection can be provided.

[0031] As described above, the first conductive layer terminal **51**T electrically connected to the first conductive layer **51** is provided. The potential of the first conductive layer terminal **51**T may be fixed. The potential of the first conductive layer terminal **51**T may be, for example, a ground potential. The first conductive layer **51** functions, for example, as a ground layer. Thereby, potential is stabilized, noise is suppressed, and higher accuracy is obtained.

[0032] For example, the potential of the first resistance portion **11***a* may be set to a first potential (ground ionization) of the first conductive layer terminal **51**T. The potential of the first conductive portion **21***a* may be set to the first potential (ground potential). The first conductive layer terminal **51**T may be electrically connected to the controller **70**. The first other resistance portion **11***b* may be electrically connected to the controller **70**. The first other conductive portion **21***b* may be electrically connected to the controller **70**.

[0033] In the embodiment, a first conductive region area of the first conductive region **51***c* in a first plane PL**1** crossing the first direction D**1** is preferably larger than a first element area of the first element **11**E in the first plane PL**1**. The first plane PL**1** is, for example, an X-Y plane. A first other conductive region area of the first other conductive region **51***d* in the first plane PL**1** is preferably larger than the first element area of the first element **11**E in the first plane PL**1**. When these conductive regions are large, for example, thermal uniformity can be improved. Thereby, more stable detection can be performed.

[0034] As shown in FIGS. **1**C, **2**A, and **2**C, the sensor **110** may further include a first temperature detection element **58**. The controller **70** may be configured to output a value obtained by correcting the first electrical resistance based on a value detected by the first temperature detection element **58**. Thereby, detection results with higher accuracy can be obtained.

[0035] As shown in FIG. **1**C and FIG. **2**B, the first conductive layer **51** may further include a first temperature detection region **51***x*. The first temperature detection region **51***x* may be continuous with the first conductive region **51***c*. The boundaries between these conductive regions may be clear or unclear. The first temperature detection region **51***x* may overlap the first temperature detection element **58** in the first direction D**1**. The temperature in the first temperature detection element **58** becomes more stable.

[0036] As shown in FIG. **2**B, the first conductive layer **51** may further include a first fixed portion region **51***a* being continuous with the first conductive region **51***c*. A position of the first fixed portion **11**F in a third direction D**3** is between a position of the first fixed portion region **51***a* in the third direction D**3** and a position of the first intermediate region **41***c* in the third direction D**3**. The third direction D**3** crosses a plane including the first direction D**1** and the second direction D**2**. The third direction D**3** may be, for example, the X-axis direction. By providing the first fixed portion region **51***a*, a more uniform temperature distribution is obtained.

[0037] As shown in FIGS. **1**A and **2**B, the first detection section **10**A may further include a first other fixed portion **11**G fixed to the first base region **41**. The first element **11**E is further supported by the first other fixed portion **11**G. The first conductive layer **51** further includes a first other fixed portion region **51***b* being continuous with the first conductive region **51***c*. A position of the first other fixed portion **11**G in the third direction D**3** is between a position of the first intermediate region **41***c* in the third direction D**3** and a position of the first other fixed portion region **51***b* in the third direction D**3**. By providing the first other fixed portion region **51***b*, a more uniform temperature distribution can be obtained.

[0038] As shown in FIG. **1**B and FIG. **2**B, the sensor **110** may further include a second detection section **10**B. The base **40** may further include a second base region **42** including a second intermediate region **42***c*.

[0039] The second detection section **10**B includes a second fixed portion **12**F fixed to the second base region **42** and a second element **12**E supported by the second fixed portion **12**F. The second element **12**E includes the second resistance member **12**.

[0040] The first conductive layer **51** further includes a second conductive region **52***c* and a second other conductive region **52***d* being continuous with the first conductive region **51***c* and the first other conductive region **51***d*. A position of the second intermediate region **42***c* in the second direction D**2** is between a position of the second conductive region **52***c* in the second direction D**2** and a position of the second other conductive region **52***d* in the second direction D**2**. In the first direction D**1**, a second gap g**2** is provided between the second intermediate region **42***c* and the second element **12**E.

[0041] The controller **70** may be configured to output a value corresponding to a difference between the second electrical resistance of the second resistance member **12** and the first electrical resistance of the first resistance member **11**. The second element **12**E may function as a reference element, for example. As described above, the temperature of the first resistance member **11** changes by supplying the first current to the first conductive member **21** of the first element **11**E. On the other hand, no power is supplied to the second element **12**E, and the temperature of the second resistance member **12** does not substantially change. By detecting the difference between the first electrical resistance and the second electrical resistance, for example, a detection result that suppresses the influence of ambient temperature can be obtained. For example, compensated results are obtained.

[0042] In the embodiment, the controller **70** may be configured to output a value obtained by correcting the difference between the second electrical resistance of the second resistance member **12** and the first electrical resistance of the first resistance member **11** by the value detected by the first temperature detection element **58**. As a result, a detection result with higher accuracy can be obtained.

[0043] In the embodiment, the first conductive layer **51** is provided with a second conductive region **52***c* and a second other conductive region **52***d*. Thereby, for example, heat uniformity can be improved. More stable detection becomes possible.

[0044] In the embodiment, the second element **12**E may include a second conductive member **22**. The second conductive member **22** does not need to be supplied with power. The second conductive member **22** is, for example, a dummy conductive member. By providing the second conductive member **22**, for example, the thermal characteristics (e.g., heat capacity) of the second element **12**E become the same as the thermal characteristics (e.g., heat capacity) of the first element **11**E. Higher accurate compensation is obtained.

[0045] The first conductive layer **51** may further include a second fixed portion region **52***a* being continuous with the second conductive region **52***c*. A position of the second fixed portion **12**F in the third direction D**3** is between a position of the second fixed portion region **52***a* in the third direction D**3** and a position of the second intermediate region **42***c* in the third direction D**3**. The third direction D**3** crosses a plane including the first direction D**1** and the second direction D**2**. The second fixed portion region **52***a* can further improve heat uniformity.

[0046] The second detection section **10**B may further include a second other fixed portion **12**G fixed to the second base region **42**. The second element **12**E is further supported by the second other fixed portion **12**G. The first conductive layer **51** may further include a second other fixed portion region **52***b* being continuous with the second conductive region **52***c*. A position of the second other fixed portion **12**G in the third direction D**3** is between a position of the second intermediate region **42***c* in the third direction D**3** and a position of the second other fixed portion region **52***b* in the third direction D**3**. The heat uniformity can be further improved by the second other fixed portion region **52***b*.

[0047] As shown in FIG. **2**A, the first detection section **10**A may further include a first connecting portion **11**C. The first connecting portion **11**C is supported by the first fixed portion **11**F. The first connecting portion **11**C supports the first element **11**E. A width of the first connecting portion **11**C in the third direction D**3** is smaller than a width of the first element **11**E in the third direction D**3**. A part of the first gap g**1** is provided between the first base region **41** and the first connecting portion **11**C.

[0048] The first detection section **10**A may further include a first other connecting portion **11**D. The first other connecting portion **11**D is supported by the first other fixed portion **11**G. The first other connecting portion **11**D supports the first element **11**E. A width of the first other connecting portion **11**D in the third direction D**3** is smaller than the width of the first element **11**E in the third direction D**3**. A part of the first gap g**1** is provided between the first base region **41** and the first other connecting portion **11**D.

[0049] As shown in FIG. **1**A, for example, a first resistance wiring **11***a*L electrically connected to the first resistance portion **11***a* may pass through the first connecting portion **11**C and the first fixed portion **11**F. For example, a first conductive wiring **21***a*L electrically connected to the first conductive portion **21***a* may pass through the first connecting portion **11**C and the first fixed portion **11**F.

[0050] As shown in FIG. **1**A, for example, a first other resistance wiring **11***b*L electrically connected to the first other resistance portion **11***b* may pass through the first other connecting portion **11**D and the first other fixed portion **11**G. For example, a first other conductive wiring **21***b*L electrically connected to the first other conductive portion **21***b* may pass through the first other connecting portion **11**D and the first other fixed portion **11**G.

[0051] One of the first resistance wiring **11***a*L and the first other resistance wiring **11***b*L may be set to the first potential. One of the first conductive wiring **21***a*L and the first other conductive wiring **21***b*L may be set to the first potential.

[0052] As shown in FIG. **2**A, the second detection section **10**B may further include a second connecting portion **12**C. The second connecting portion **12**C is supported by the second fixed portion **12**F. The second connecting portion **12**C supports the second element **12**E. A width of the second connecting portion **12**C in the third direction D**3** is smaller than a width of the second element **12**E in the third direction D**3**. A part of the second gap g**2** is provided between the second base region **42** and the second connecting portion **12**C.

[0053] The second detection section **10**B may further include a second other connecting portion **12**D. The second other connecting portion **12**D is supported by the second other fixed portion **12**G. The second other connecting portion **12**D supports the second element **12**E. A width of the second other connecting portion **12**D in the third direction D**3** is smaller than the width of the second element **12**E in the third direction **D3**. A part of the second gap **g2** is provided between the second base region **42** and the second other connecting portion **12**D.

[0054] As shown in FIG. **1**B, the second resistance member **12** includes a second resistance portion **12***a* and a second other resistance portion **12***b*. The second conductive member **22** includes a second conductive portion **22***a* and a second other conductive portion **22***b*.

[0055] As shown in FIG. **1**B, for example, a second resistance wiring **12***a*L electrically connected to the second resistance portion **12***a* may pass through the second connecting portion **12**C and the second fixed portion **12**F. For example, a second conductive wiring **22***a*L electrically connected to the second conductive portion **22***a* may pass through the second connecting portion **12**C and the second fixed portion **12**F.

[0056] As shown in FIG. **1**B, for example, a second other resistance wiring **12***b*L electrically connected to the second other resistance portion **12***b* may pass through the second other connecting portion **12**D and the second other fixed portion **12**G. For example, the second other conductive wiring **22***b*L electrically connected to the second other conductive portion **22***b* may pass through the second other connecting portion **12**D and the second other fixed portion **12**G.

[0057] One of the second resistance wiring **12***a*L and the second other resistance wiring **12***b*L may be set to the first potential. One of the second conductive wiring **22***a*L and the second other conductive wiring **22***b*L may be set to the first potential. The controller **70** does not need to supply the second conductive member **22** with an electric power.

[0058] As shown in FIGS. **1**A and **1**B, the first element **11**E may include a first insulating member **11***i*. The first insulating member **11***i* is provided around the first resistance member **11** and the first conductive member **21**. The second element **12**E may include a second insulating member **12***i*. The second insulating member **12***i* is provided around the second resistance member **12** and the second conductive member **22**.

[0059] At least one of the first insulating member **11***i* or the second insulating member **12***i* may include, for example, silicon nitride. As described later, at least one of the first insulating member **11***i* or the second insulating member **12***i* may include a metal oxide or the like. The first insulating member **11***i* may be provided at the first connecting portion **11**C and the first other connecting portion **11**D. The second insulating member **12***i* may be provided at the second connecting portion **12**C and the second other connecting portion **12**D.

[0060] FIGS. **4**A to **4**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0061] As shown in FIGS. **4**A to **4**C, in a sensor **111** according to the embodiment, a part of the first conductive layer **51** overlaps the first fixed portion **11**F in the first direction D**1**. In this example, a part of the first conductive layer **51** overlaps the first other fixed portion **11**G in the first direction D**1**. A part of the first conductive layer **51** overlaps the second fixed portion **12**F in the first direction D**1**. In this example, a part of the first conductive layer **51** overlaps the second other fixed portion **12**G in the first direction D**1**. The configuration of the sensor **111** except for these may be the same as the configuration of the sensor **110**. The sensor **111** can also provide a sensor capable of highly accurate detection.

[0062] A part of the first conductive layer **51** may overlap the first connecting portion **11**C in the first direction D**1**. A part of the first conductive layer **51** may overlap the first other connecting portion **11**D in the first direction D**1**. A part of the first conductive layer **51** may overlap the second connecting portion **12**C in the first direction D**1**. A part of the first conductive layer **51** may overlap the second other connecting portion **12**D in the first direction D**1**.

[0063] FIGS. **5**A to **5**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0064] As shown in FIGS. **5**A to **5**C, in a sensor **112** according to the embodiment, the first conductive layer **51** includes holes **51***h*. The configuration of the sensor **112** except for this may be the same as the configuration of the sensor **110**, or the configuration of the sensor **111**. Thermal conductivity is appropriately controlled by the holes **51***h*. The sensor **112** can also provide a sensor capable of highly accurate detection.

[0065] FIGS. **6**A to **6**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0066] As shown in FIGS. **6**A to **6**C, in a sensor **113** according to the embodiment, the first conductive layer **51** includes a first conductive film **51***f* and a second conductive film **52***f*. At least a part of the second conductive film **52***f* overlaps the first conductive film **51***f* in the first direction D**1**. The second conductive film **52***f* is electrically connected to the first conductive film **51***f*. A part of the base **40** may be provided between the first conductive film **51***f* and the second conductive film **52***f*. In this example, a part of the second insulating layer **40***j* is provided between the first conductive film **51***f* and the second conductive film **52***f*. The configuration of the sensor **113** except for these may be the same as the configuration of the sensors **110** to **112**. Low electrical resistance can be obtained by the first conductive film **51***f* and the second conductive film **52***f*. High uniformity of heat is obtained.

[0067] FIGS. **7**A to **7**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0068] As shown in FIGS. **7**A to **7**C, in a sensor **114** according to the embodiment, the controller **70** includes a control element **45**. The control element **45** may be, for example, a switching element such as a transistor. The control element **45** may overlap at least one of the first element **11**E and the first conductive layer **51** in the first direction D**1**. In this example, the control element **45** overlaps the first element **11**E in the first direction D**1**. The control element **45** may overlap the second element **12**E in the first direction D**1**. It becomes easy to obtain a small sensor. Noise is suppressed. The configuration of the sensor **114** except for this may be the same as the configuration of the sensors **110** to **113**. In this example, the control element **45** includes a CMOS **46** (Complementary Metal Oxide Semiconductor).

[0069] FIGS. **8**A to **8**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0070] As shown in FIGS. **8**A and **8**C, in a sensor **115** according to the embodiment, at least a part of the first temperature detection element **58** overlaps the first element **11**E in the first direction D**1**. The configuration of sensor **115** except for this may be the same as the configuration of sensors **110** to **114**. By the first temperature detection element **58** overlapping the first element **11**E, the temperature of the first element **11**E can be detected with higher accuracy.

[0071] As shown in FIG. **8**B, a second temperature detection element **59** may be provided in the sensor **115**. At least a part of the second temperature detection element **59** may overlap the second element **12**E in the first direction D**1**. By the second temperature detection element **59** overlapping the second element **12**E, the temperature of the second element **12**E can be detected with higher accuracy. The controller **70** may correct the detected value based on the value detected by the second temperature detection element **59**.

Second Embodiment

[0072] FIGS. **9**A to **9**C are schematic cross-sectional views illustrating a sensor according to the first embodiment.

[0073] FIG. **9**A is a cross-sectional view corresponding to the line A**1**-A**2** in FIG. **2**A. FIG. **9**B is a sectional view corresponding to the line A**3**-A**4** in FIG. **2**A. FIG. **9**C is a cross-sectional view corresponding to the line A**5**-A**6** in FIG. **2**A.

[0074] As shown in FIG. **9**A, in a sensor **120** according to the embodiment, the first detection section **10**A includes a first fixed electrode **51**E. The configuration of sensor **120** except for this may be the same as the configuration of sensors **110** to **115**.

[0075] In the sensor **120**, the first fixed electrode **51**E is fixed to the first base region **41**. A first gap g**1** is provided between the first fixed electrode **51**E and the first conductive member **21**. In the sensor **120**, a distance between the first fixed electrode **51**E and the first conductive member **21** changes depending on the state of the detection target existing around the first element **11**E. The detection target can be detected by detecting the first capacitance between the first fixed electrode **51**E and the first conductive member **21** according to the change in distance.

[0076] In this example, the first insulating member **11***i* includes a first layer **61***a* at the first connecting portion **11**C. The volume of the first layer **61***a* changes depending on the detection target (for example, hydrogen, etc.) that exists around the first element **11**E. Stress is applied to the first connecting portion **11**C due to the change in the volume of the first layer **61***a*. Due to the stress, the distance between the first fixed electrode **51**E and the first conductive member **21** changes.

[0077] For example, the first insulating member **11***i* includes a first other layer **61***b* in the first other connecting portion **11**D. The volume of the first other layer **61***b* changes depending on the detection target existing around the first element **11**E. Due to the change in volume of the first other layer **61***b*, stress is applied to the first other connecting portion **11**D. Due to the stress, the distance between the first fixed electrode **51**E and the first conductive member **21** changes.

[0078] In the sensor **120**, the second element **12**E includes a second conductive member **22**. In the sensor **120**, the second detection section **10**B includes a second fixed electrode **52**E. The second fixed electrode **52**E is fixed to the second base region **42**. The second gap g**2** is provided between the second fixed electrode **52**E and the second conductive member **22**. The distance between the second fixed electrode **52**E and the second conductive member **22** changes depending on the state of the detection target existing around the second element **12**E. The detection target can be detected by detecting the second capacitance between the second fixed electrode **52**E and the second conductive member **22** in accordance with the change in distance.

[0079] In this example, the second insulating member **12***i* includes a second layer **62***a* at the second connecting portion **12**C. The volume of the second layer **62***a* changes depending on the detection target (for example, hydrogen, etc.) that exists around the second element **12**E. Stress is applied to the second connecting portion **12**C due to the change in the volume of the second layer **62***a*. Due to the stress, the distance between the second fixed electrode **52**E and the second conductive member **22** changes.

[0080] For example, the second insulating member **12***i* includes a second other layer **62***b* in the second other connecting portion **12**D. The volume of the second other layer **62***b* changes depending on the detection target existing around the second element **12**E. Due to the change in the volume of the second other layer **62***b*, stress is applied to the second other connecting portion **12**D. Due to the stress, the distance between the second fixed electrode **52**E and the second conductive member **22** changes.

[0081] At least one of the first layer **61***a*, the first other layer **61***b*, the second layer **62***a*, or the second other layer **62***b* includes, for example, a metal oxide. At least one of the first layer **61***a*, the first other layer **61***b*, the second layer **62***a*, or the second other layer **62***b* includes, for example, oxygen and at least one metal selected from the group consisting of Pt, Pd, and Ti.

[0082] In the second embodiment, the first conductive member **21** and the second conductive member **22** function as fixed electrodes, for example. In the second embodiment, the first resistance member **11** and the second resistance member **12** function as a heater, for example.

[0083] In the first embodiment and the second embodiment, the controller **70** may include, for example, at least one of a gas detection circuit, a temperature detection circuit, a heater voltage generation circuit, or a control circuit. The gas detection circuit may include an electrical resistance detection section or a capacitance detection section.

[0084] In the embodiment, at least one of the first resistance member **11** or the second resistance member **12** may include at least one selected from the group consisting of, for example, TiN, Ti, W, A1, Cu, AlCu, Si, and Pd. At least one of the first conductive member **21** or the second conductive member **22** may include, for example, at least one selected from the group consisting of TIN, Ti, W, A1, Cu, AlCu, Si, and Pd.

[0085] The embodiments may include the following Technical proposals:

(Technical Proposal 1)

[0086] A sensor, comprising:

- **[0087]** a base including a first base region including a first intermediate region;
- **[0088]** a first detection section;

[0089] a first conductive layer fixed to the base, the first conductive layer including a first conductive region and a first other conductive region; and

[0090] a first conductive layer terminal electrically connected to the first conductive layer,

[0091] the first detection section including:

[0092] a first fixed portion fixed to the first base region, and

[0093] a first element supported by the first fixed portion,

[0094] the first element including a first resistance member and a first conductive member,

[0095] a position of the first intermediate region in a second direction crossing a first direction from the first base region to the first fixed portion being between a position of the first conductive region in the second direction and a position of the first other conductive region in the second direction, and

[0096] a first gap being provided between the first intermediate region and the first element in the first direction.

(Technical Proposal 2)

[0097] The sensor according to Technical proposal 1, wherein

[0098] a first conductive region area of the first conductive region in a first plane crossing the first direction is larger than a first element area of the first element in the first plane.

(Technical Proposal 3)

[0099] The sensor according to Technical proposal 1 or 2, wherein

[0100] the first resistance member includes a first resistance portion and a first other resistance portion,

[0101] the first conductive member includes a first conductive portion and a first other conductive portion,

[0102] a potential of the first resistance portion is set to a first potential of the first conductive layer terminal, and

[0103] a potential of the first conductive portion is fixed to the first potential.

(Technical Proposal 4)

[0104] The sensor according to Technical proposal 3, wherein

[0105] a first power is supplied between the first conductive portion and the first other conductive portion, and

[0106] a first electrical resistance between the first resistance portion and the first other resistance portion is detected.

(Technical Proposal 5)

[0107] The sensor according to Technical proposal 4, further comprising:

[0108] a controller,

[0109] the controller being configured to supply the first power, and

[0110] the controller being configured to detect the first electrical resistance.

(Technical Proposal 6)

[0111] The sensor according to Technical proposal 5, wherein

[0112] the first electrical resistance is configured to change depending on a detection target existing in a space around the first element.

(Technical Proposal 7)

[0113] The sensor according to Technical proposal 6, further comprising:

[0114] a first temperature detection element,

[0115] the controller being configured to output a value obtained by correcting the first electrical resistance based on a value detected by the first temperature detection element.

(Technical Proposal 8)

[0116] The sensor according to Technical proposal 7, wherein

[0117] the first conductive layer further includes a first temperature detection region being continuous with the first conductive region, and

[0118] the first temperature detection region overlaps the first temperature detection element in the first direction.

(Technical Proposal 9)

[0119] The sensor according to any one of Technical proposals 1-8, wherein

[0120] a part of the first conductive layer overlaps the first fixed portion in the first direction.

(Technical Proposal 10)

[0121] The sensor according to any one of Technical proposals 1-9, wherein

[0122] the first conductive layer further includes a first fixed portion region being continuous with the first conductive region,

[0123] a position of the first fixed portion in a third direction is between a position of the first fixed portion region in the third direction and a position of the first intermediate region in the third direction, and

[0124] the third direction crosses a plane including the first direction and the second direction.

(Technical Proposal 11)

[0125] The sensor according to Technical proposal 10, wherein

[0126] the first detection section further includes a first other fixed portion fixed to the first base region,

[0127] the first element is further supported by the first other fixed portion,

[0128] the first conductive layer further includes a first other fixed portion region being continuous with the first conductive region, and

[0129] a position of the first other fixed portion in the third direction is between the position of the first intermediate region in the third direction and a position of the first other fixed portion region in the third direction.

(Technical Proposal 12)

[0130] The sensor according to Technical proposal 7 or 8, further comprising:

[0131] a second detection section,

[0132] the base further including a second base region including a second intermediate region,

[0133] the second detection section including:

[0134] a second fixed portion fixed to the second base region, and

[0135] a second element supported by the second fixed portion,

[0136] the second element including a second resistance member,

[0137] the first conductive layer further including a second conductive region and a second other conductive region being continuous with the first conductive region and the first other conductive region,

[0138] a position of the second intermediate region in the second direction being between a position of the second conductive region in the second direction and a position of the second other conductive region in the second direction, and

[0139] a second gap being provided between the second intermediate region and the second element in the first direction.

(Technical Proposal 13)

[0140] The sensor according to Technical proposal 12, wherein

[0141] the controller is configured to output a value obtained by correcting a difference between a second electrical resistance of the second resistance member and the first electrical resistance using a value detected by the first temperature detection element.

(Technical Proposal 14)

[0142] The sensor according to Technical proposal 12 or 13, wherein

[0143] the first conductive layer further includes a second fixed portion region being continuous with the second conductive region,

[0144] a position of the second fixed portion in a third direction is between a position of the second fixed portion region in the third direction and a position of the second intermediate region in the third direction, and

[0145] the third direction crosses a plane including the first direction and the second direction.

(Technical Proposal 15)

[0146] The sensor according to Technical proposal 14, wherein

[0147] the second detection section further includes a second other fixed portion fixed to the second base region,

[0148] the second element is further supported by the second other fixed portion,

[0149] the first conductive layer further includes a second fixed portion region being continuous with the second conductive region, and

[0150] the position of the second other fixed portion in the third direction is between the position of the second intermediate region in the third direction and a position of the second other fixed portion region in the third direction.

(Technical Proposal 16)

[0151] The sensor according to any one of Technical proposals 12-15, wherein

[0152] the controller includes a control element, and

[0153] the control element overlaps at least one of the first element or the first conductive layer in the first direction.

(Technical Proposal 17)

[0154] The sensor according to Technical proposal 16, wherein

[0155] the control element includes a CMOS (Complementary Metal Oxide Semiconductor).

(Technical Proposal 18)

[0156] The sensor according to any one of Technical proposals 12-17, wherein

[0157] the second element further includes a second conductive member.

(Technical Proposal 19)

[0158] The sensor according to any one of Technical proposals 1-18, wherein

[0159] the first conductive layer includes a first conductive film and a second conductive film,

[0160] at least a part of the second conductive film overlaps the first conductive film in the first direction,

[0161] the second conductive film is electrically connected to the first conductive film, and

[0162] a part of the base is provided between the first conductive film and the second conductive film.

(Technical Proposal 20)

[0163] The sensor according to any one of Technical proposals 1-19, wherein

[0164] the first conductive layer includes a hole.

[0165] According to the embodiment, a sensor capable of highly accurate detection can be provided.

[0166] In the specification of the application, "perpendicular" and "parallel" refer to not only strictly perpendicular and strictly parallel but also include, for example, the fluctuation due to manufacturing processes, etc. It is sufficient to be substantially perpendicular and substantially parallel.

[0167] Hereinabove, exemplary embodiments of the invention are described with reference to specific examples. However, the embodiments of the invention are not limited to these specific examples. For example, one skilled in the art may similarly practice the invention by appropriately selecting specific configurations of components included in sensors such as bases, detection sections, resistance members, conductive members, temperature detection elements, circuits, etc., from known art. Such practice is included in the scope of the invention to the extent that similar effects thereto are obtained.

[0168] Further, any two or more components of the specific examples may be combined within the extent of technical feasibility and are included in the scope of the invention to the extent that the purport of the invention is included.

[0169] Moreover, all sensors practicable by an appropriate design modification by one skilled in the art based on the sensors described above as embodiments of the invention also are within the scope of the invention to the extent that the purport of the invention is included.

[0170] Various other variations and modifications can be conceived by those skilled in the art within the spirit of the invention, and it is understood that such variations and modifications are also encompassed within the scope of the invention.

[0171] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

What is claimed is:

1. A sensor, comprising:

a base including a first base region including a first intermediate region;

a first detection section;

a first conductive layer fixed to the base, the first conductive layer including a first conductive region and a first other conductive region; and

a first conductive layer terminal electrically connected to the first conductive layer,

the first detection section including:

a first fixed portion fixed to the first base region, and

a first element supported by the first fixed portion,

the first element including a first resistance member and a first conductive member,

a position of the first intermediate region in a second direction crossing a first direction from the first base region to the first fixed portion being between a position of the first conductive region in the second direction and a position of the first other conductive region in the second direction, and

a first gap being provided between the first intermediate region and the first element in the first direction.

2. The sensor according to claim **1**, wherein

a first conductive region area of the first conductive region in a first plane crossing the first direction is larger than a first element area of the first element in the first plane.

3. The sensor according to claim **1**, wherein

the first resistance member includes a first resistance portion and a first other resistance portion,

the first conductive member includes a first conductive portion and a first other conductive portion,

a potential of the first resistance portion is set to a first potential of the first conductive layer terminal, and

a potential of the first conductive portion is fixed to the first potential.

4. The sensor according to claim **3**, wherein

a first power is supplied between the first conductive portion and the first other conductive portion, and

a first electrical resistance between the first resistance portion and the first other resistance portion is detected.

5. The sensor according to claim **4**, further comprising:

a controller,

the controller being configured to supply the first power, and

the controller being configured to detect the first electrical resistance.

6. The sensor according to claim **5**, wherein

the first electrical resistance is configured to change depending on a detection target existing in a space around the first element.

7. The sensor according to claim **6**, further comprising:

a first temperature detection element,

the controller being configured to output a value obtained by correcting the first electrical resistance based on a value detected by the first temperature detection element.

8. The sensor according to claim **7**, wherein

the first conductive layer further includes a first temperature detection region being continuous with the first conductive region, and

the first temperature detection region overlaps the first temperature detection element in the first direction.

9. The sensor according to claim **1**, wherein

a part of the first conductive layer overlaps the first fixed portion in the first direction.

10. The sensor according to claim **1**, wherein

the first conductive layer further includes a first fixed portion region being continuous with the first conductive region,

a position of the first fixed portion in a third direction is between a position of the first fixed portion region in the third direction and a position of the first intermediate region in the third direction, and

the third direction crosses a plane including the first direction and the second direction.

11. The sensor according to claim **10**, wherein

the first detection section further includes a first other fixed portion fixed to the first base region,

the first element is further supported by the first other fixed portion,

the first conductive layer further includes a first other fixed portion region being continuous with the first conductive region, and

a position of the first other fixed portion in the third direction is between the position of the first intermediate region in the third direction and a position of the first other fixed portion region in the third direction.

12. The sensor according to claim **7**, further comprising:

a second detection section,

the base further including a second base region including a second intermediate region,

the second detection section including:

a second fixed portion fixed to the second base region, and

a second element supported by the second fixed portion,

the second element including a second resistance member,

the first conductive layer further including a second conductive region and a second other conductive region being continuous with the first conductive region and the first other conductive region, a position of the second intermediate region in the second direction being between a position of the second conductive region in the second direction and a position of the second other conductive region in the second direction, and

a second gap being provided between the second intermediate region and the second element in the first direction.

13. The sensor according to claim **12**, wherein

the controller is configured to output a value obtained by correcting a difference between a second electrical resistance of the second resistance member and the first electrical resistance using a value detected by the first temperature detection element.

14. The sensor according to claim **12**, wherein

the first conductive layer further includes a second fixed portion region being continuous with the second conductive region,

a position of the second fixed portion in a third direction is between a position of the second fixed portion region in the third direction and a position of the second intermediate region in the third direction, and

the third direction crosses a plane including the first direction and the second direction.

15. The sensor according to claim **14**, wherein

the second detection section further includes a second other fixed portion fixed to the second base region,

the second element is further supported by the second other fixed portion,

the first conductive layer further includes a second fixed portion region being continuous with the second conductive region, and

the position of the second other fixed portion in the third direction is between the position of the second intermediate region in the third direction and a position of the second other fixed portion region in the third direction.

16. The sensor according to claim **12**, wherein

the controller includes a control element, and

the control element overlaps at least one of the first element or the first conductive layer in the first direction.

17. The sensor according to claim **16**, wherein

the control element includes a CMOS (Complementary Metal Oxide Semiconductor).

18. The sensor according to claim **12**, wherein

the second element further includes a second conductive member.

19. The sensor according to claim **1**, wherein

the first conductive layer includes a first conductive film and a second conductive film,

at least a part of the second conductive film overlaps the first conductive film in the first direction,

the second conductive film is electrically connected to the first conductive film, and

a part of the base is provided between the first conductive film and the second conductive film.

20. The sensor according to claim **1**, wherein

the first conductive layer includes a hole.

* * * * *