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Yoshida

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(54) **VIDEO DISPLAY DEVICE**

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H04N 9/31	(2006.01)
H04N 5/74	(2006.01)

(52) **U.S. Cl.**
CPC ***H04N 9/3144*** (2013.01); ***H04N 5/7475*** (2013.01); ***H04N 9/3129*** (2013.01)

(58) **Field of Classification Search**
USPC 372/33–34, 36, 38.1, 38.02
See application file for complete search history.

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(57) **ABSTRACT**

A video display device includes a laser beam source module including a laser beam source emitting a laser beam and a laser beam source drive unit supplying power to the laser beam source, and an image generation unit generating a desired display image from the laser beam. The laser beam source module includes a substrate having the placed laser beam source and improved thermal conductivity, a temperature measurement member measuring a temperature of the substrate, a temperature adjustment member contacting the substrate and adjusting the temperature of the substrate, a circuit substrate electrically connecting the temperature measurement member and the laser beam source. Moreover, the circuit substrate is disposed on a rear surface opposite to a placement surface on which the laser beam source is placed, the temperature measurement member is mounted on the circuit substrate, and a portion of the temperature measurement member is connected to the substrate.

8 Claims, 13 Drawing Sheets

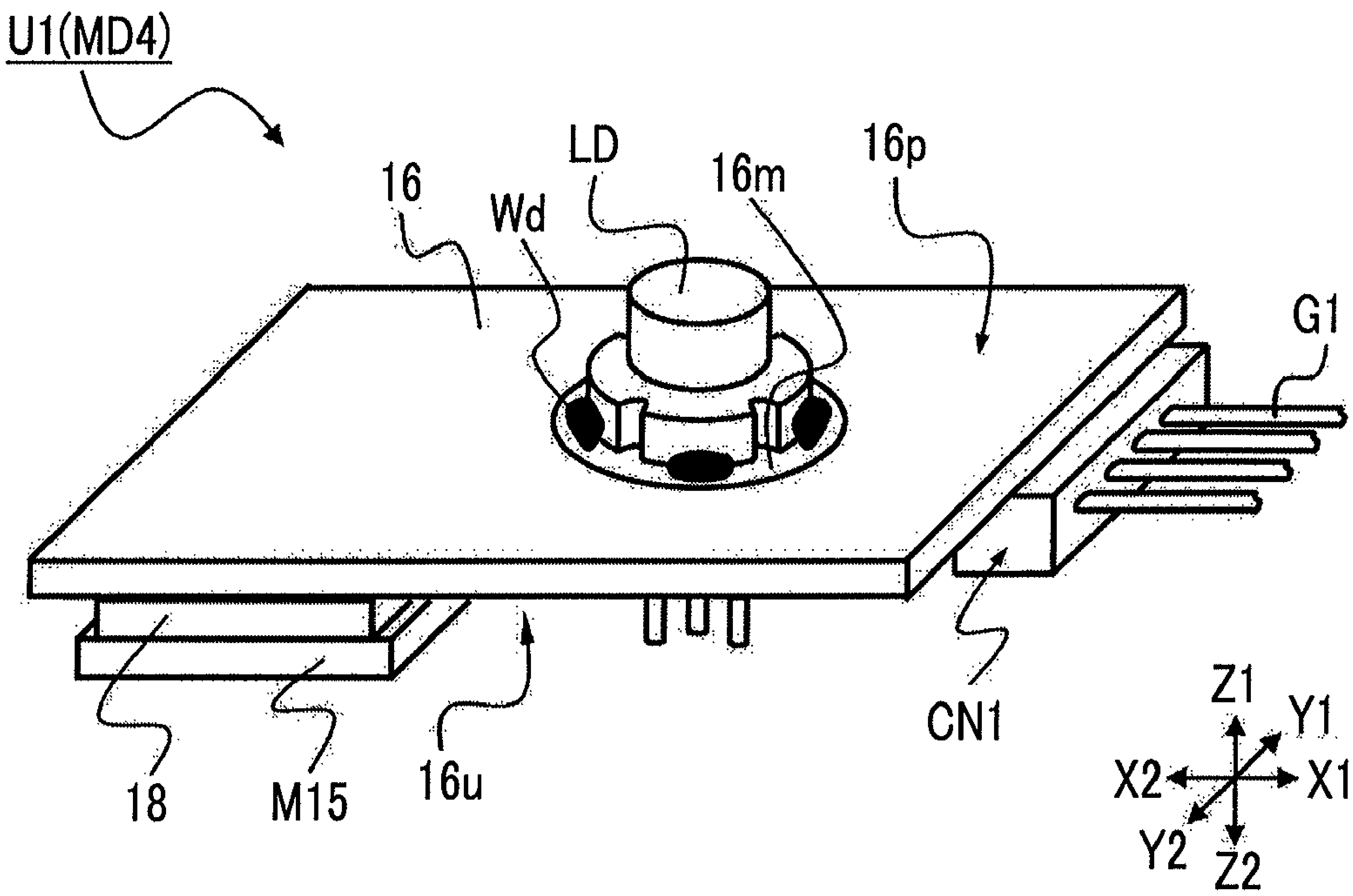
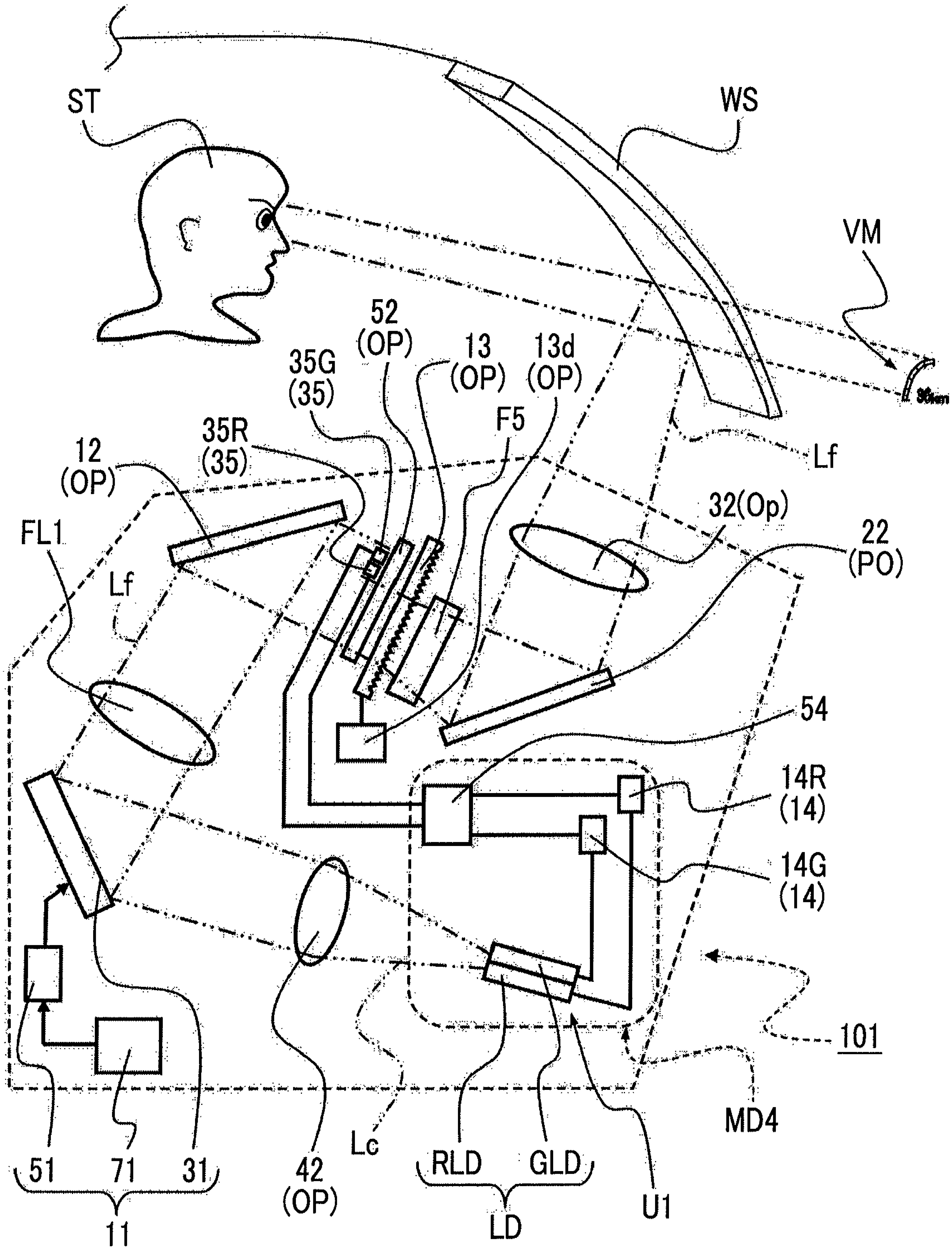


FIG. 1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13d
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F5
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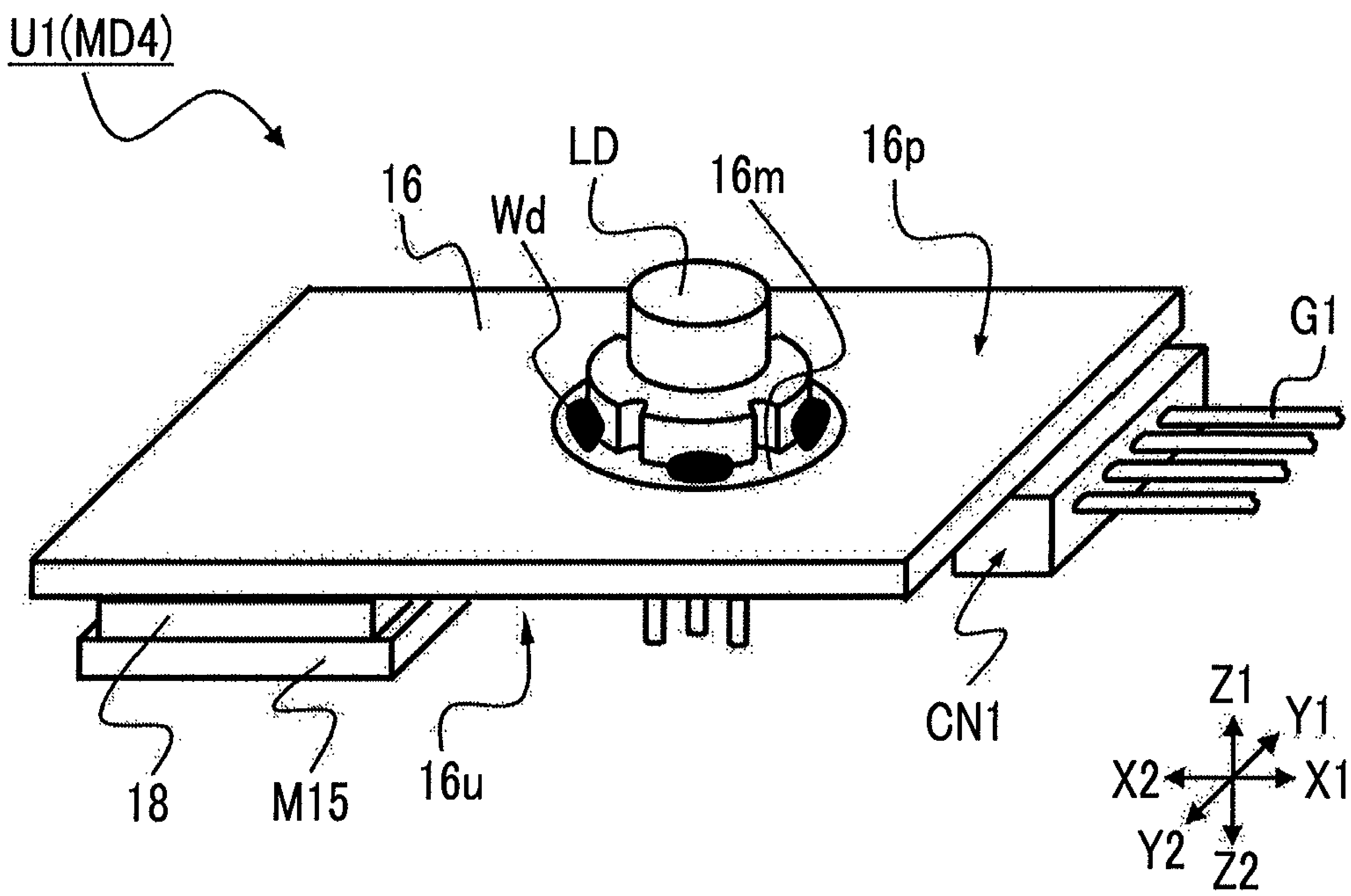
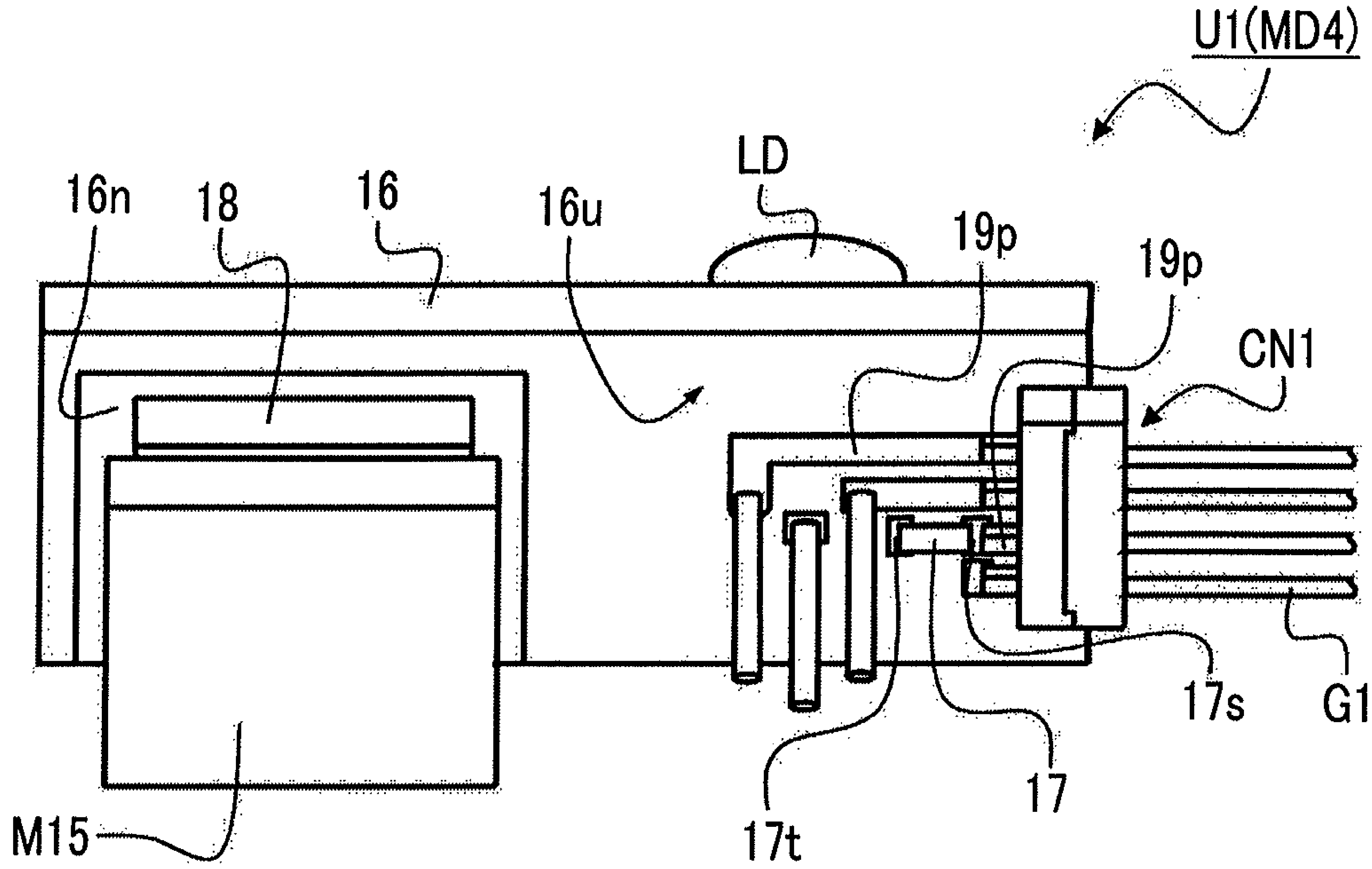
(OP)
Lf
32(Op)
22
(PO)
FL1
Lf
54
14R
(14)
14G
(14)
101
MD4
51
71
31
11
42
(OP)
Lc
RLD
GLD
LD
U1

FIG. 2A



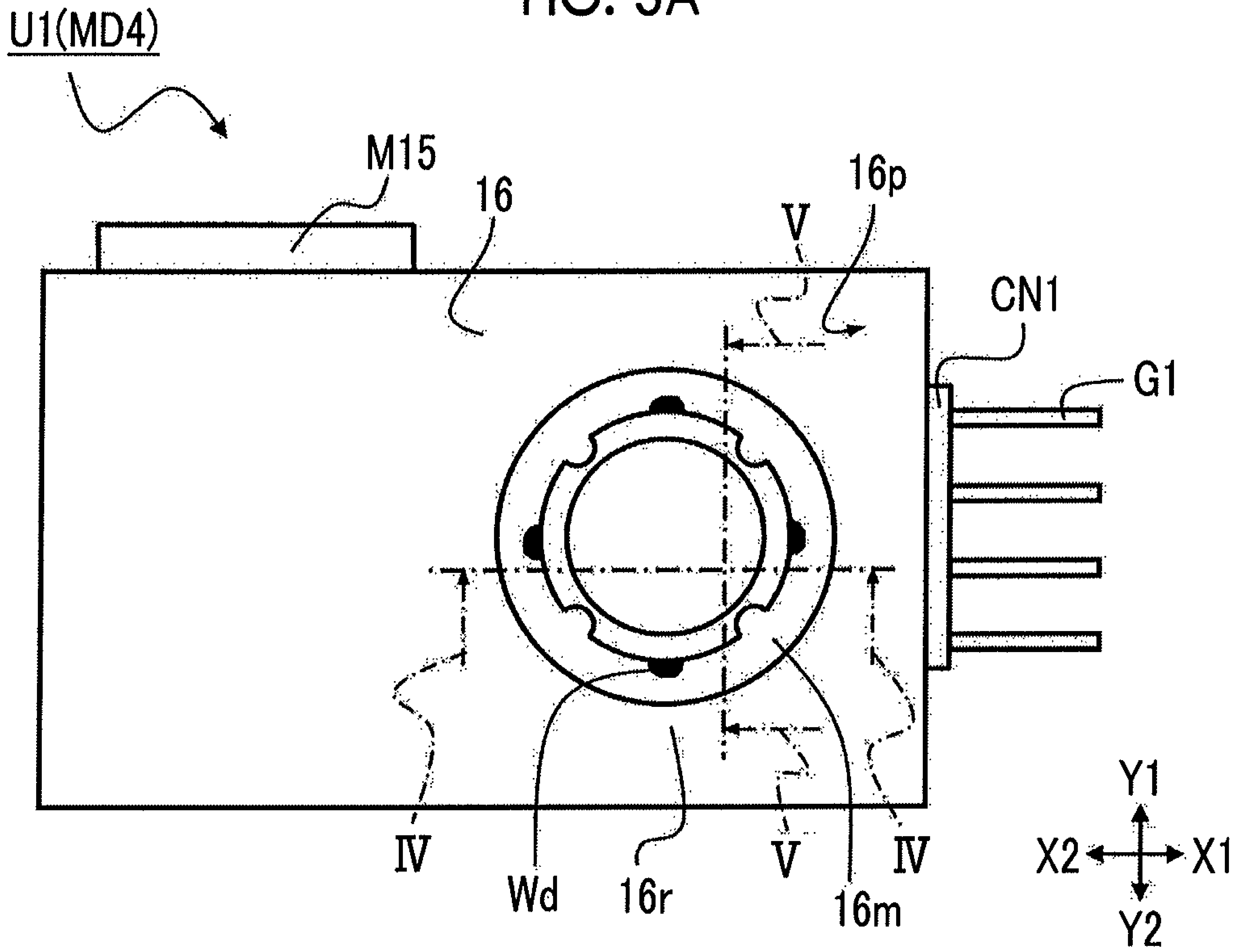
U1(MD4)
LD
16m
16p
16
Wd
G1
18
M15
16u
CN1
Z1
Y1
X2
X1
Y2
Z2

FIG. 2B



U1(MD4)
LD
16n
18
16
16u
19p
19p
CN1
17s
G1
17
17t
M15

FIG. 3A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16
16p
V
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G1
IV
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16r
V
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16m
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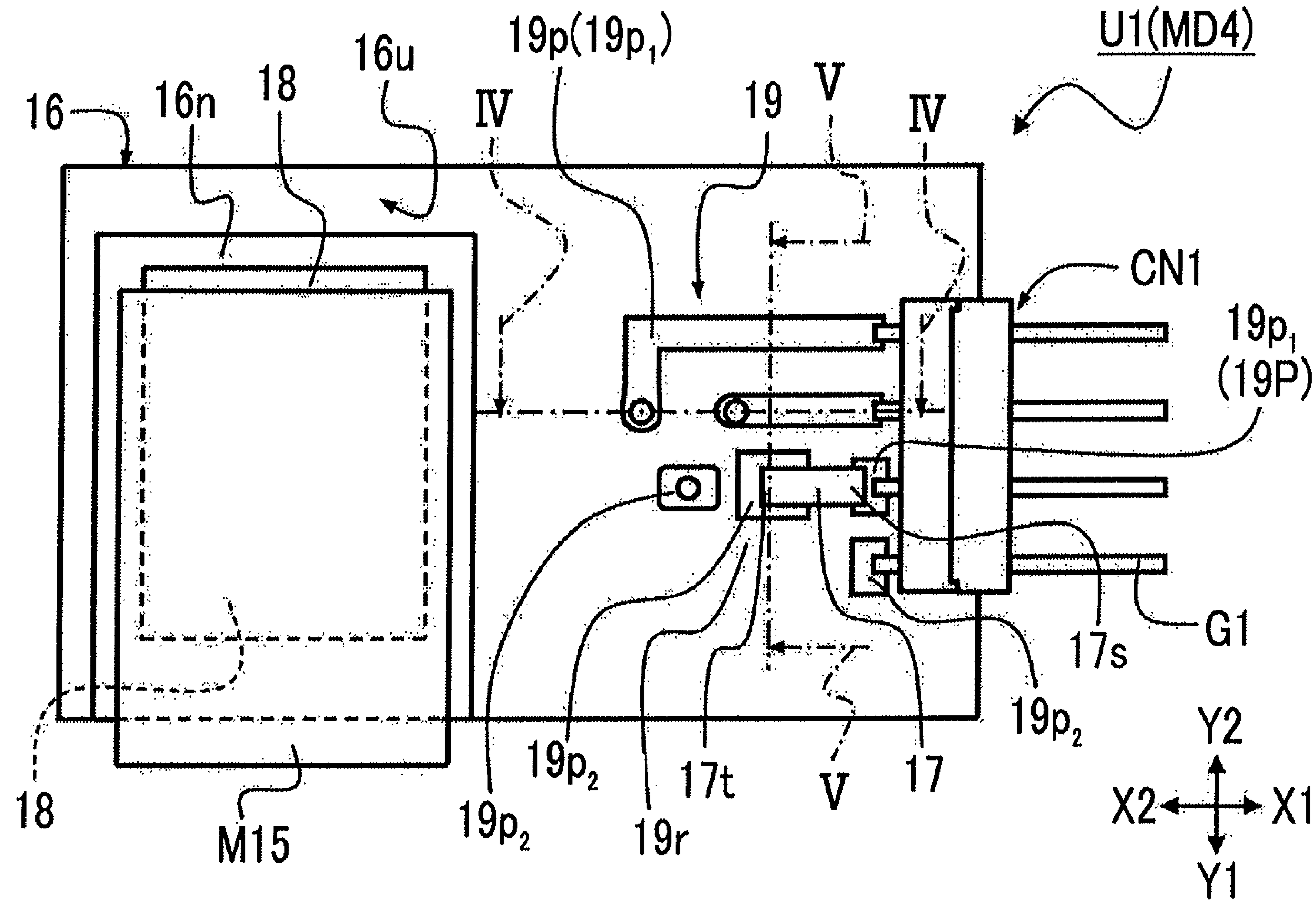
X2
X1
Y2

FIG. 3B


19p(19p1)
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16n
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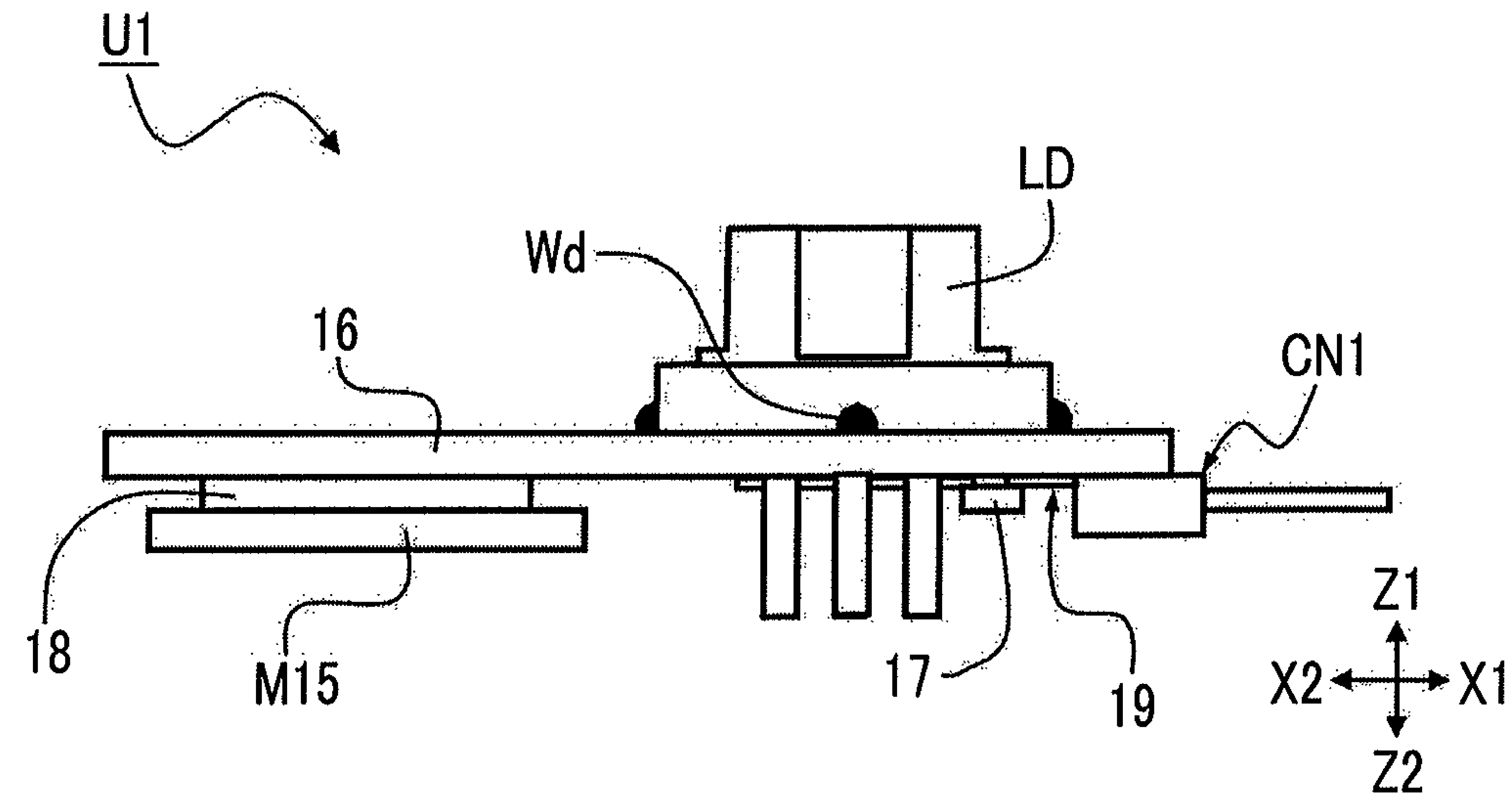
16u
IV
19
V
IV
CN1
19p1
(19P)
17s
G1
19p2
18
M15
19p2
19p2
19r
17t
V
17
Y2
X2
X1
Y1

FIG. 4A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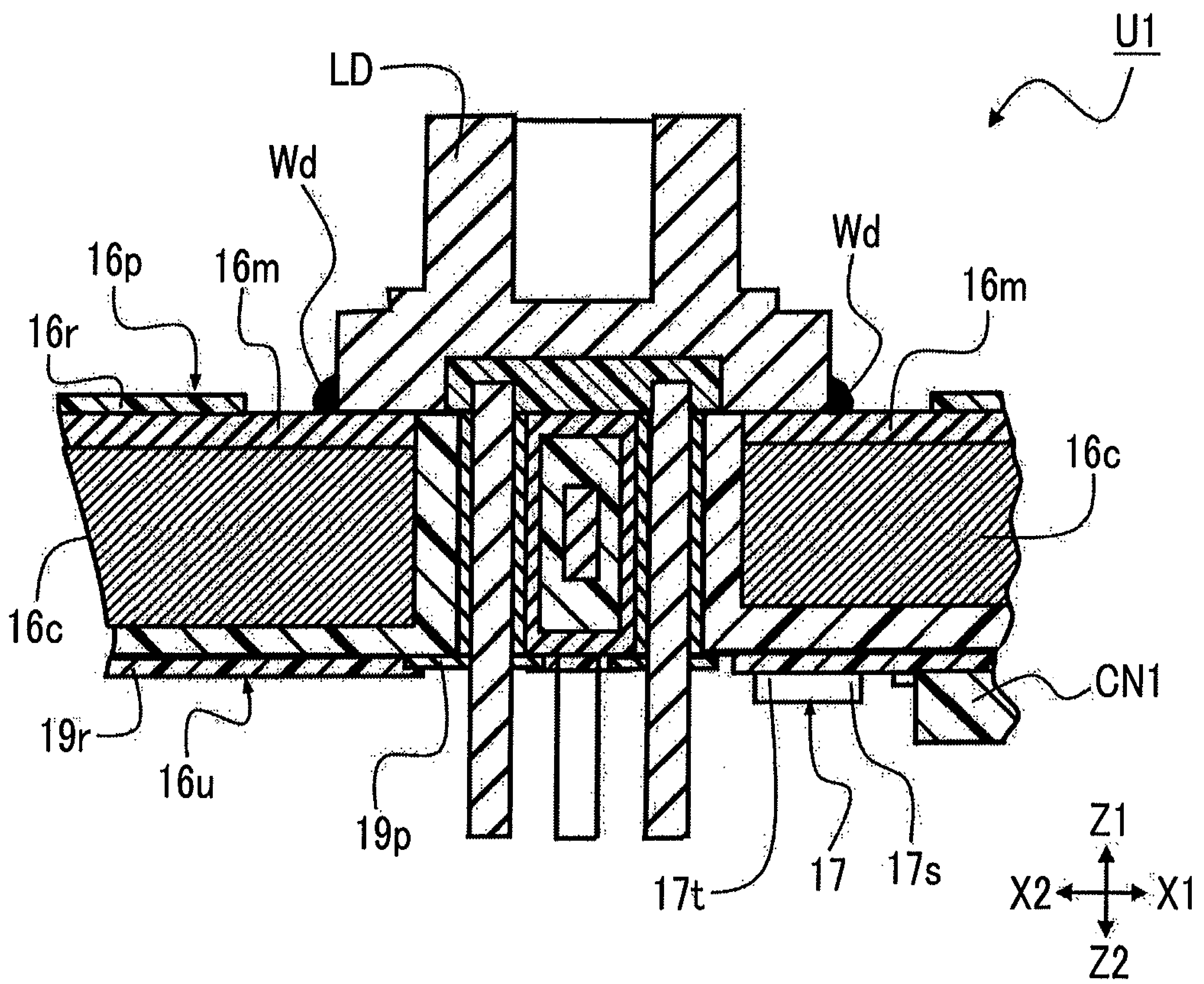
X1
Z2

FIG. 4B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16m
16m
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19p
17t
17
17s
Z1
X2
X1
Z2

FIG. 5A

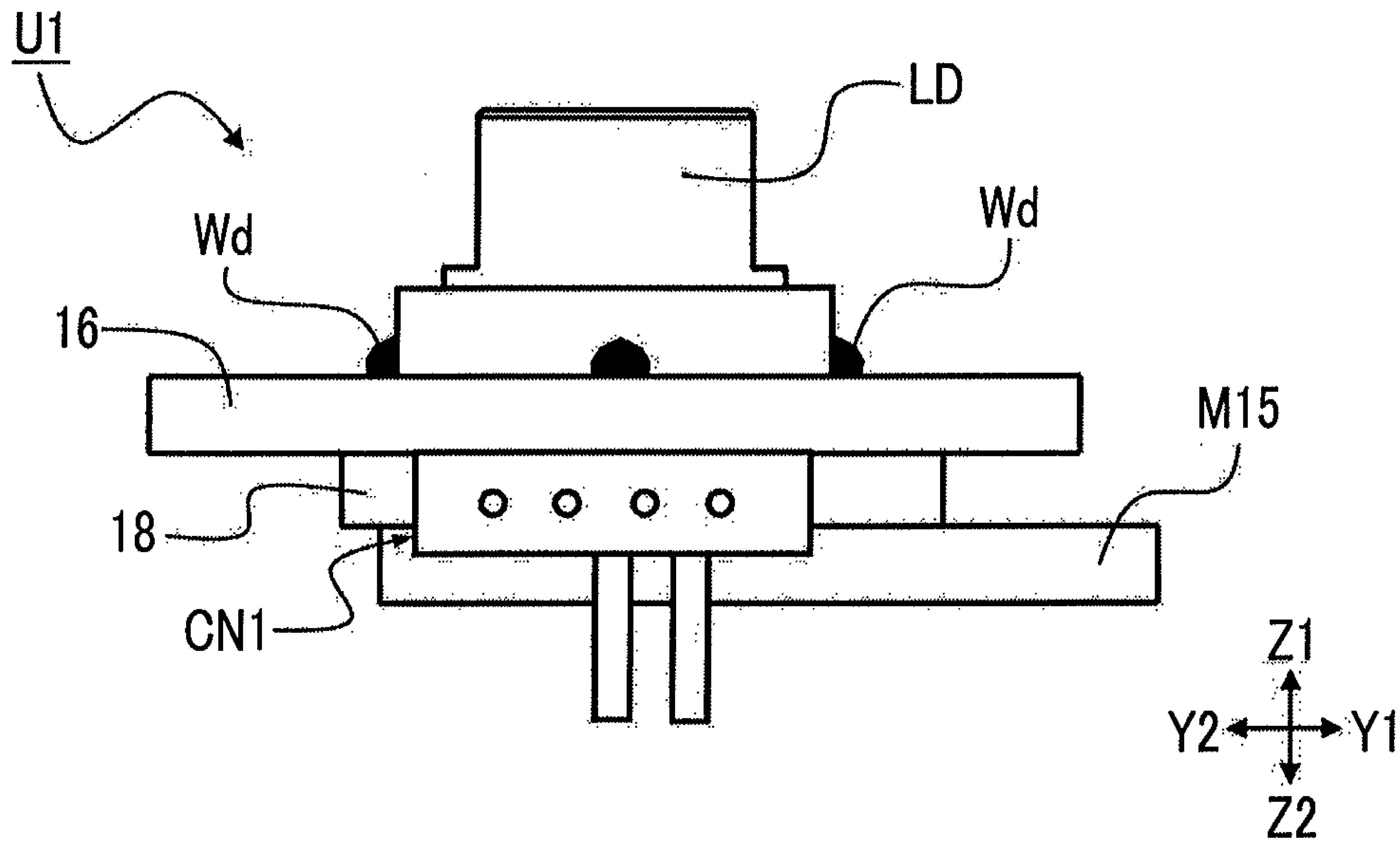

U1
LD
Wd
Wd
16
M15
18
CN1
Z1
Y2
Y1
Z2

FIG. 5B

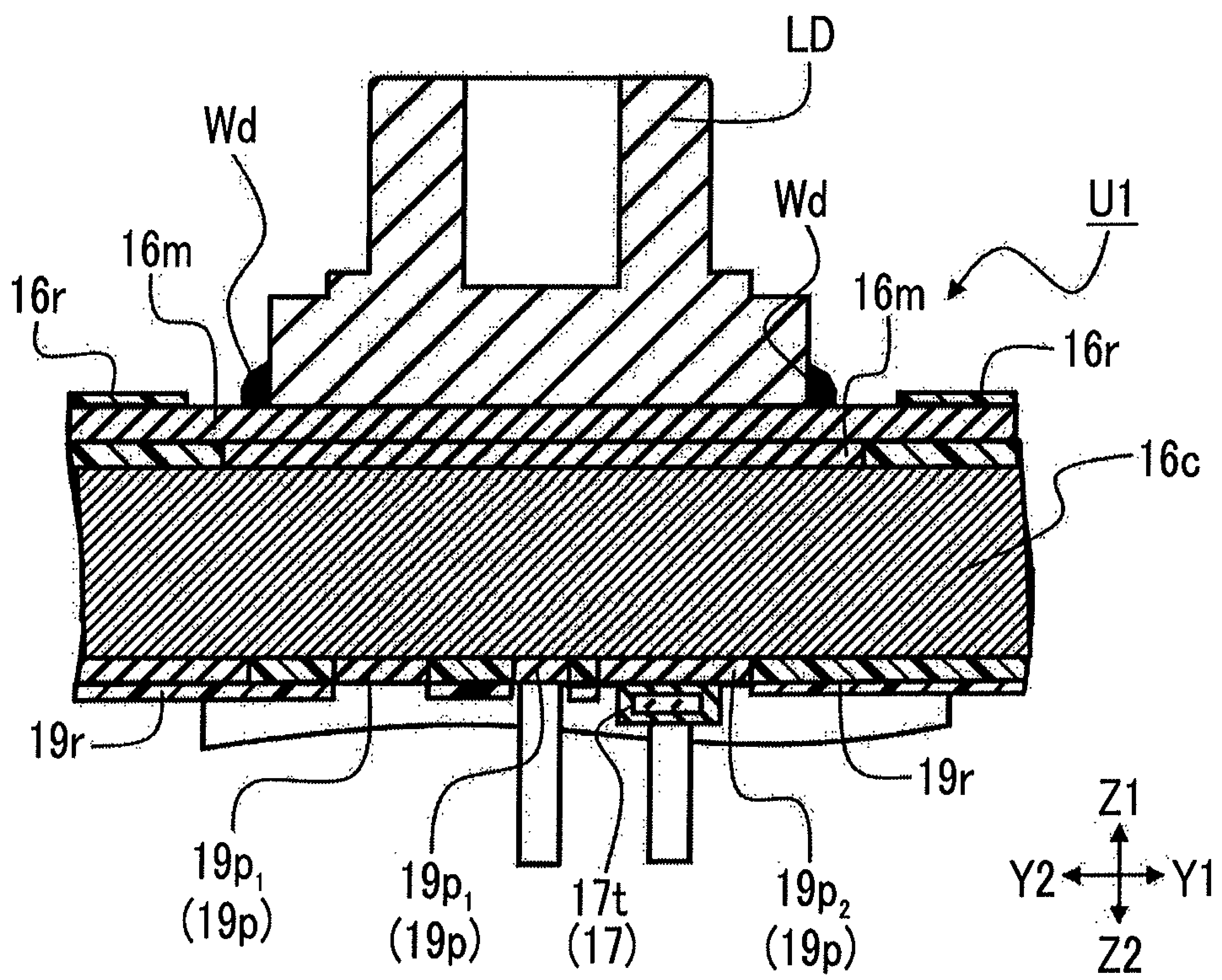

LD
Wd
Wd
U1
16m
16r
16m
16r
16c
19r
19r
19p1
(19p)
19p1
(19p)
17t
(17)
19p2
(19p)
Z1
Y2
Y1
Z2

FIG. 6

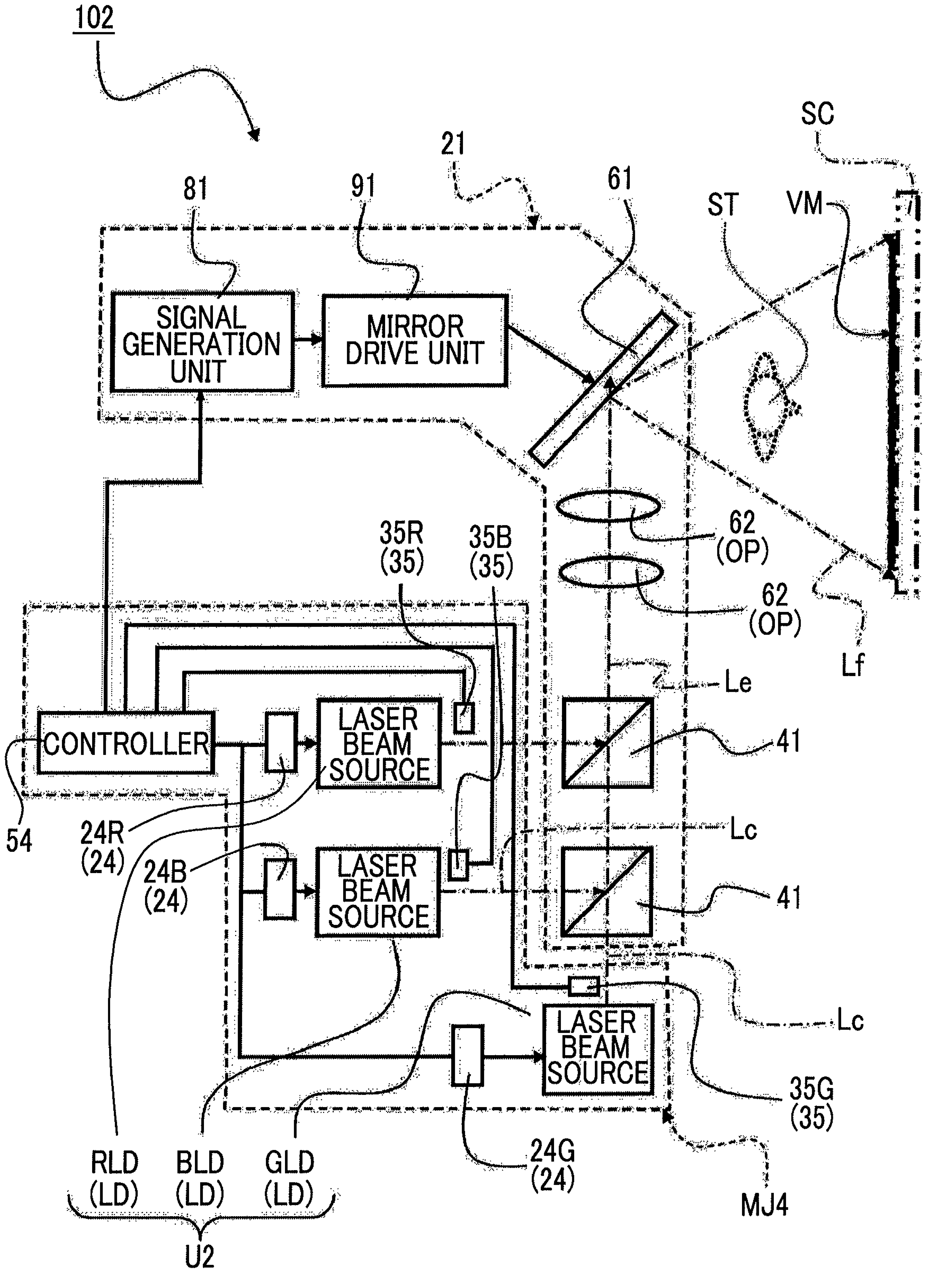

102
21
SC
81
91
61
ST
VM
SIGNAL GENERATION UNIT
MIRROR DRIVE UNIT
62 (OP)
62 (OP)
35R (35)
35B (35)
Lf
Le
CONTROLLER
LASER BEAM SOURCE
41
54
24R (24)
Lc
24B (24)
LASER BEAM SOURCE
41
Lc
LASER BEAM SOURCE
35G (35)
RLD (LD)
BLD (LD)
GLD (LD)
24G (24)
MJ4
U2

FIG. 7A

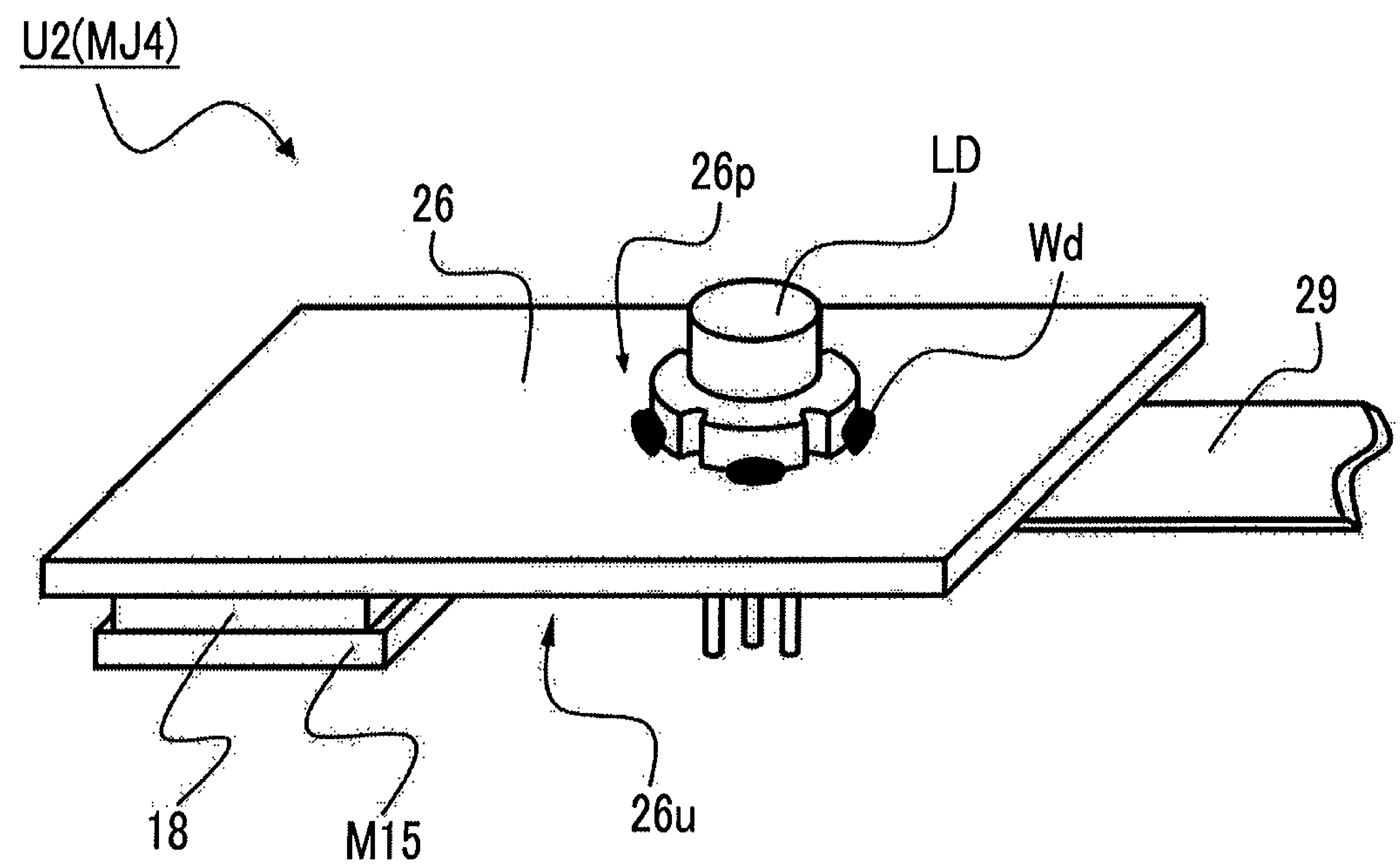
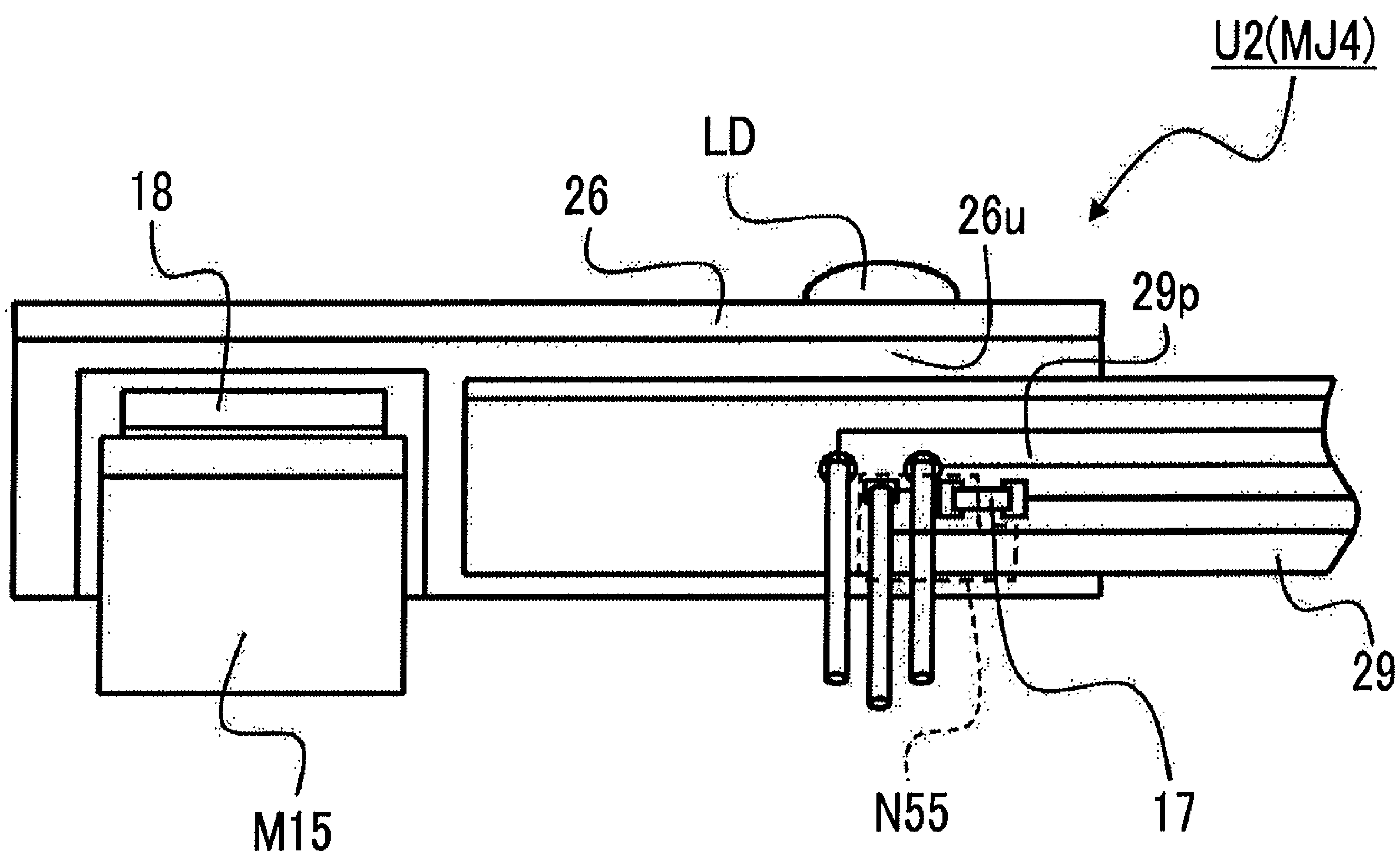

U2(MJ4)
26p
LD
Wd
26
29
18
M15
26u

FIG. 7B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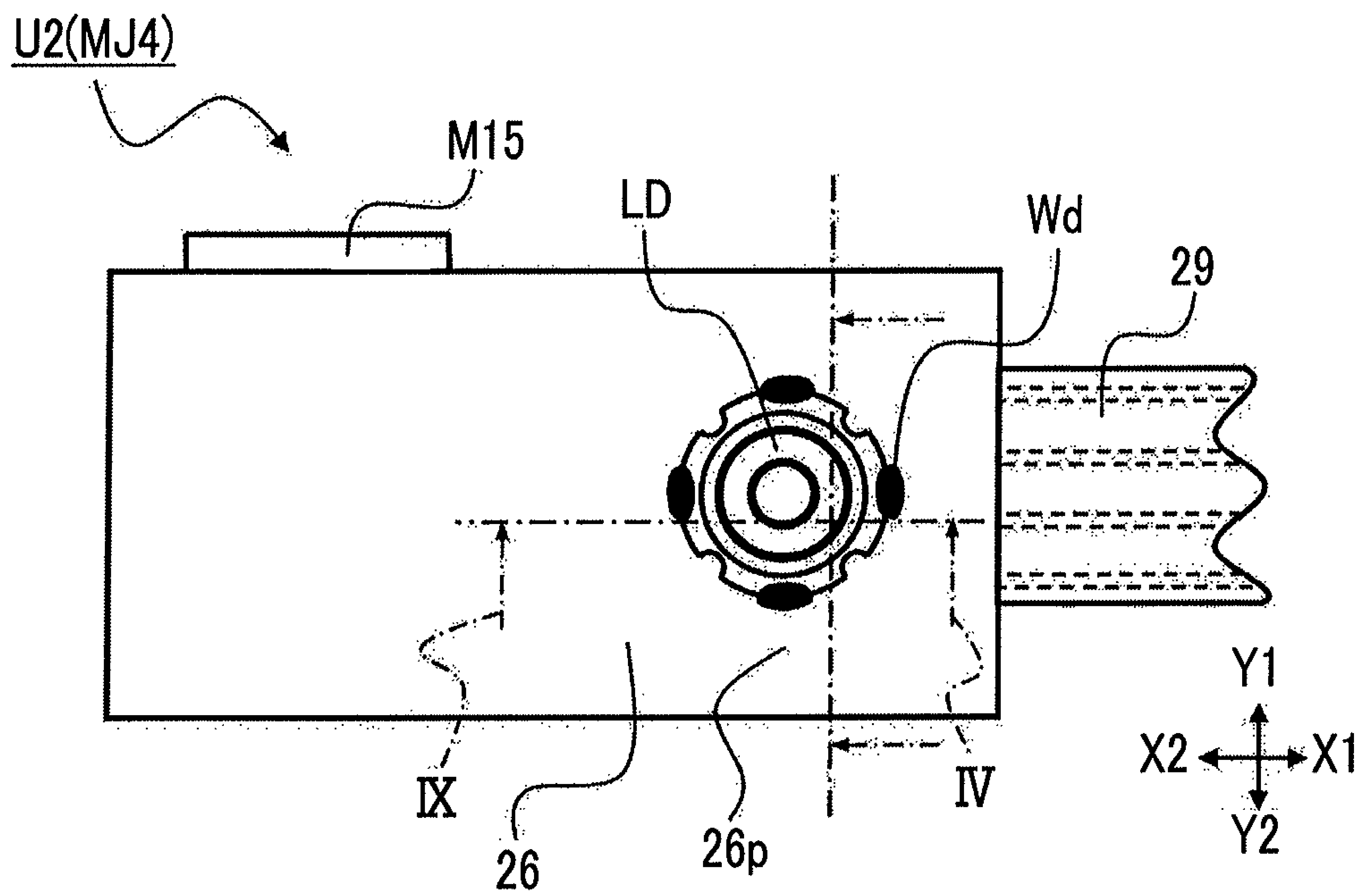
18
26
26u
29p
29
M15
N55
17

FIG. 8A


U2(MJ4)
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IX
IV
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26p
Y1
X2
X1
Y2

FIG. 8B

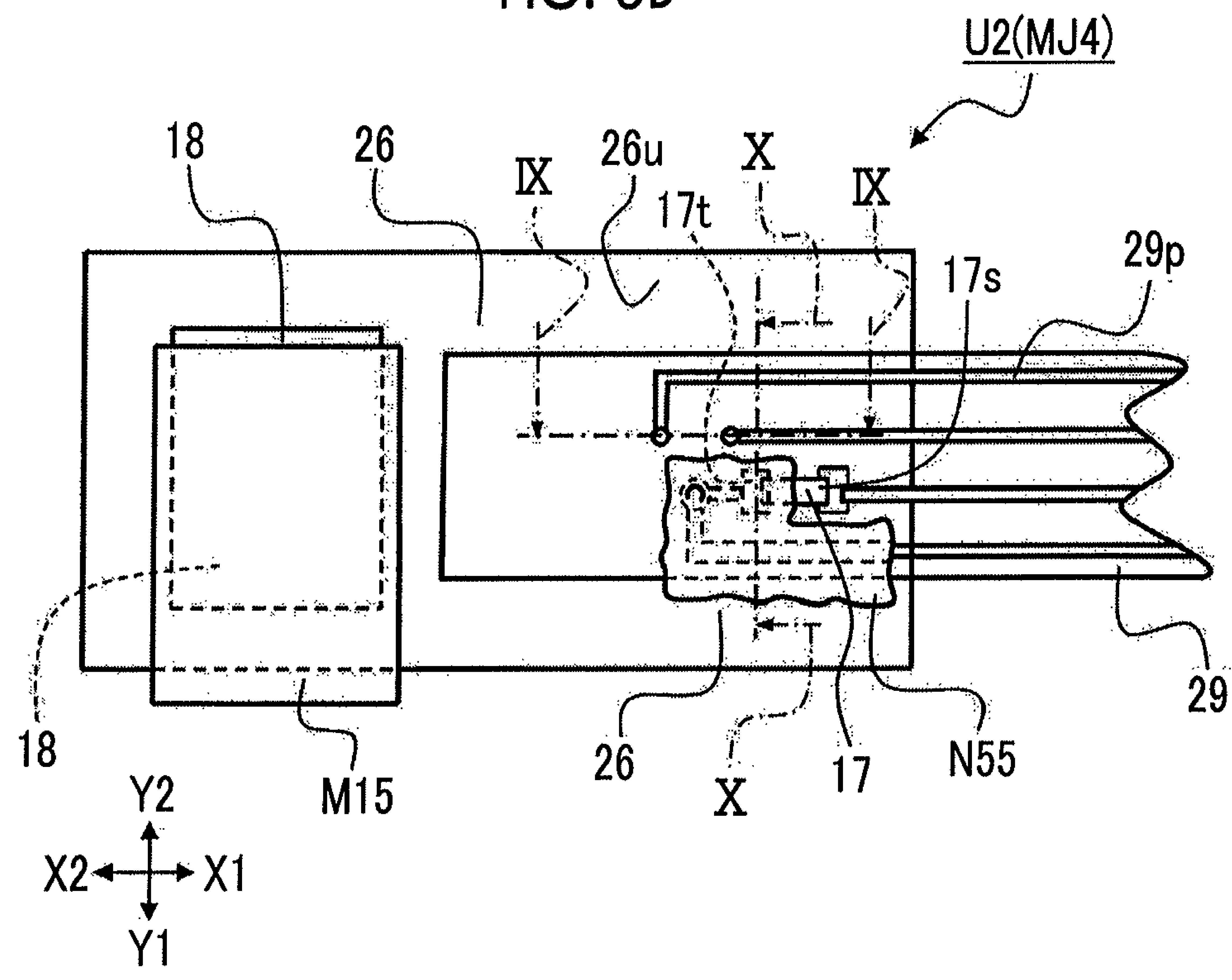
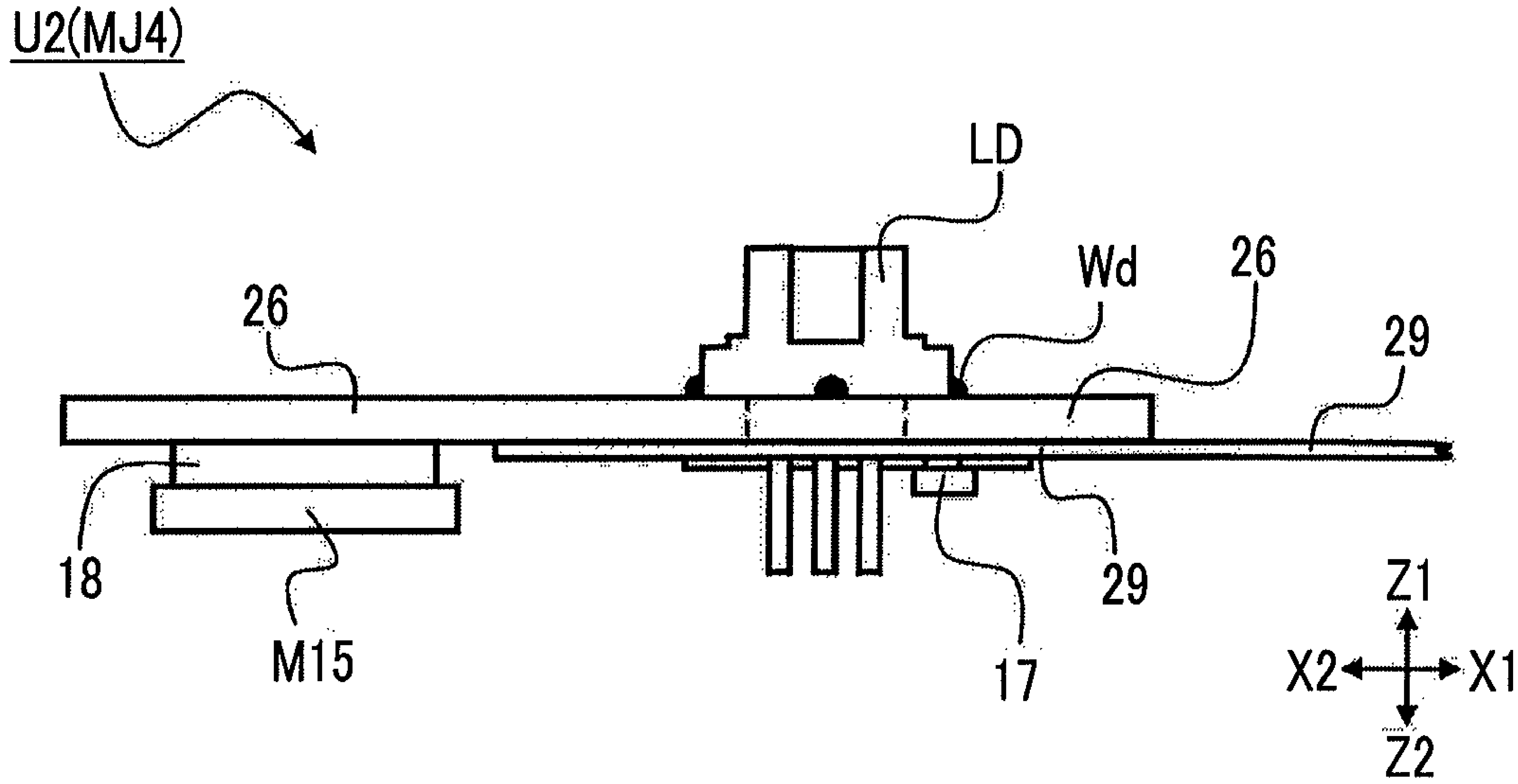

U2(MJ4)
18
26
IX
26u
17t
X
IX
17s
29p
18
M15
26
X
17
N55
29
Y2
X2
X1
Y1

FIG. 9A


U2(MJ4)
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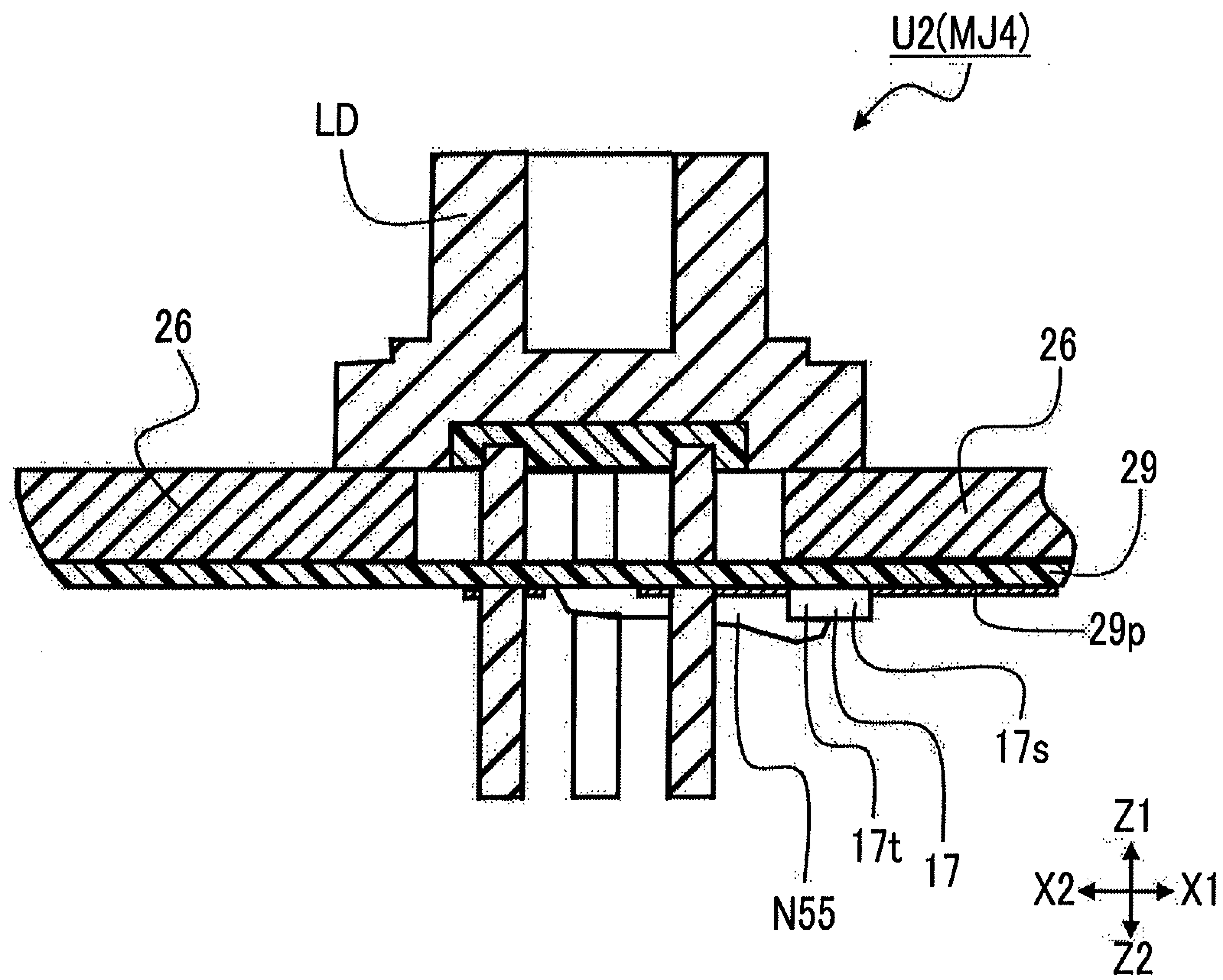
Wd
26
26
29
18
M15
29
17
Z1
X2
X1
Z2

FIG. 9B


U2(MJ4)
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17
Z1
X2
X1
Z2

FIG. 10A

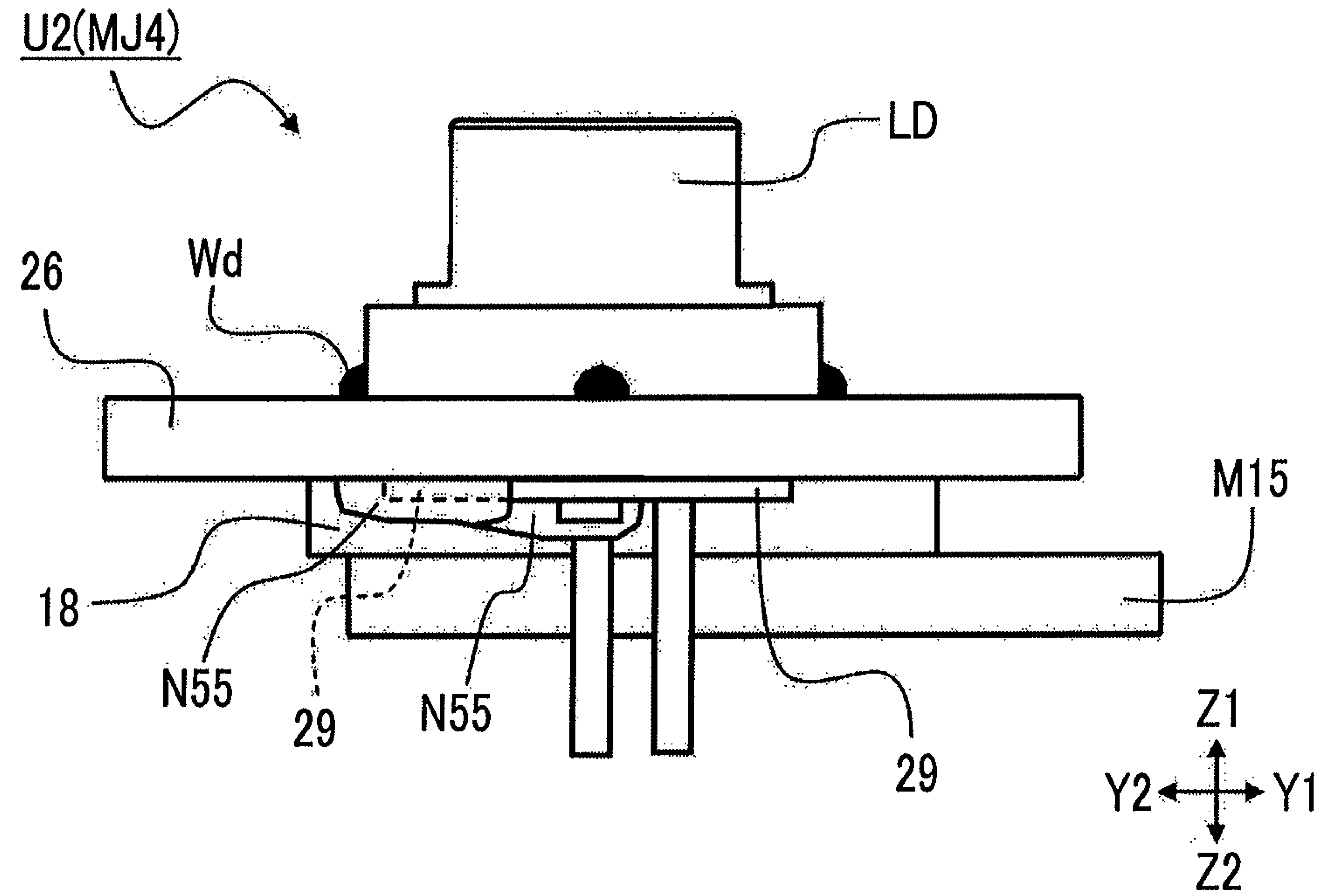


FIG. 10B

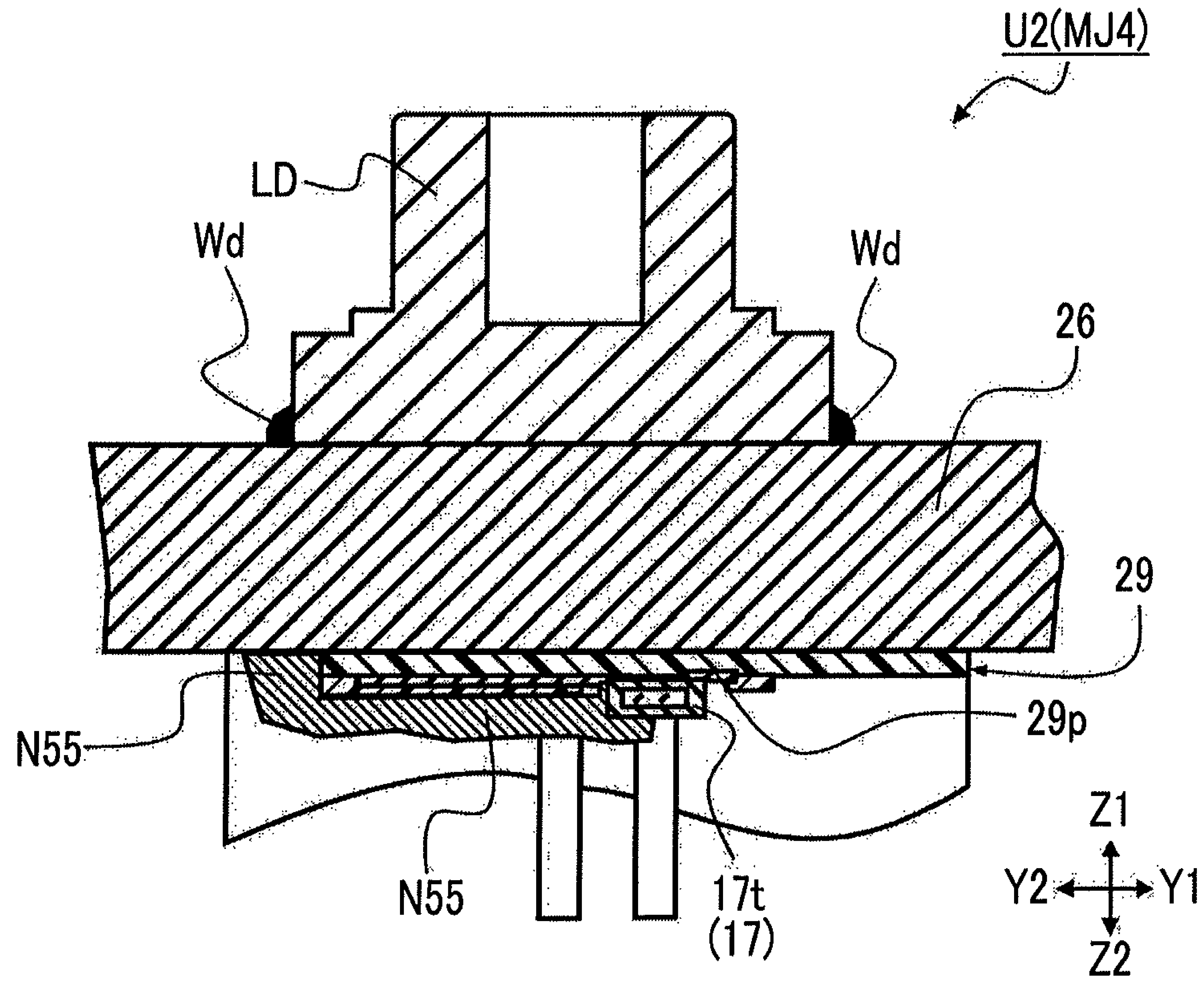


FIG. 11A

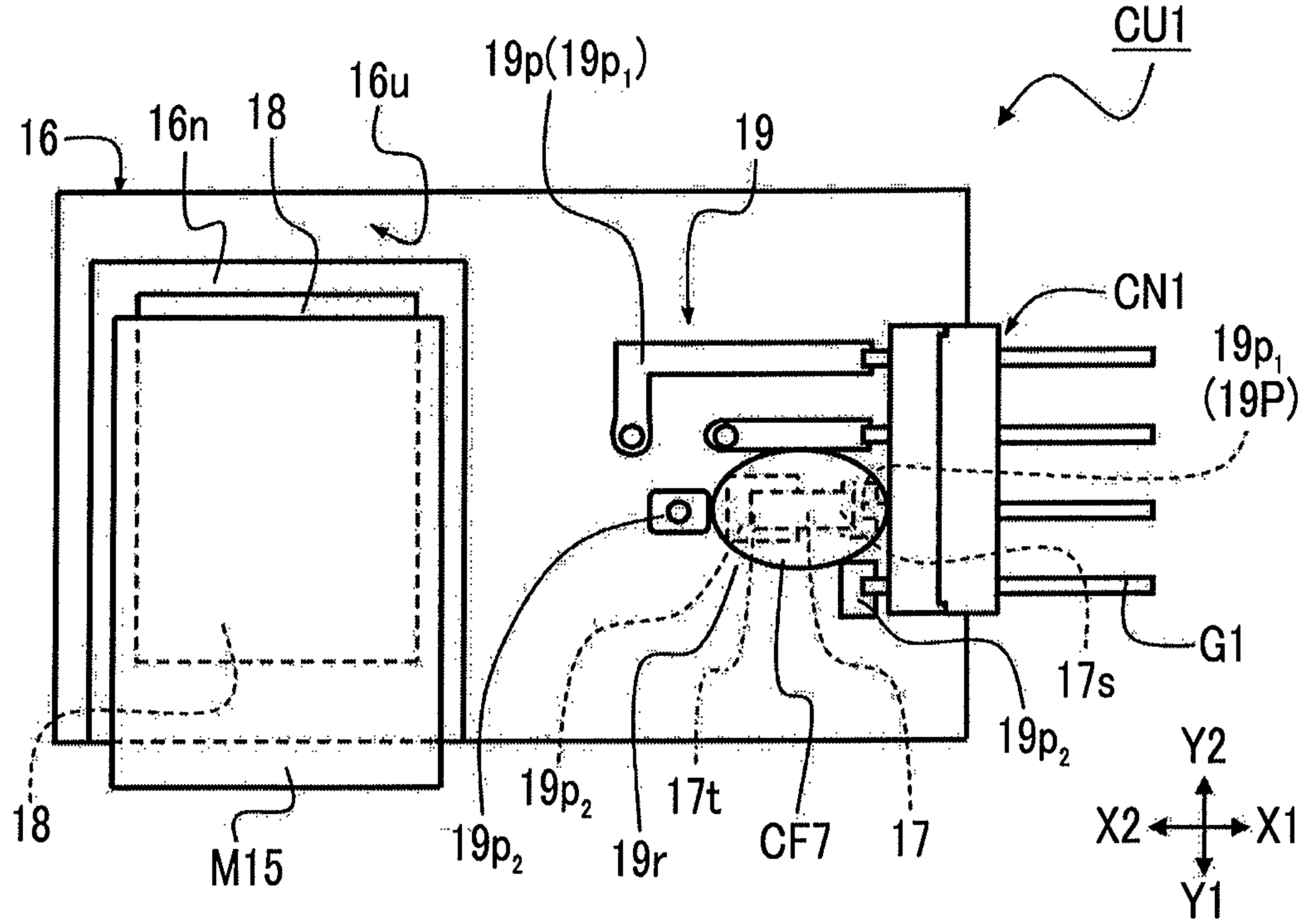


FIG. 11B

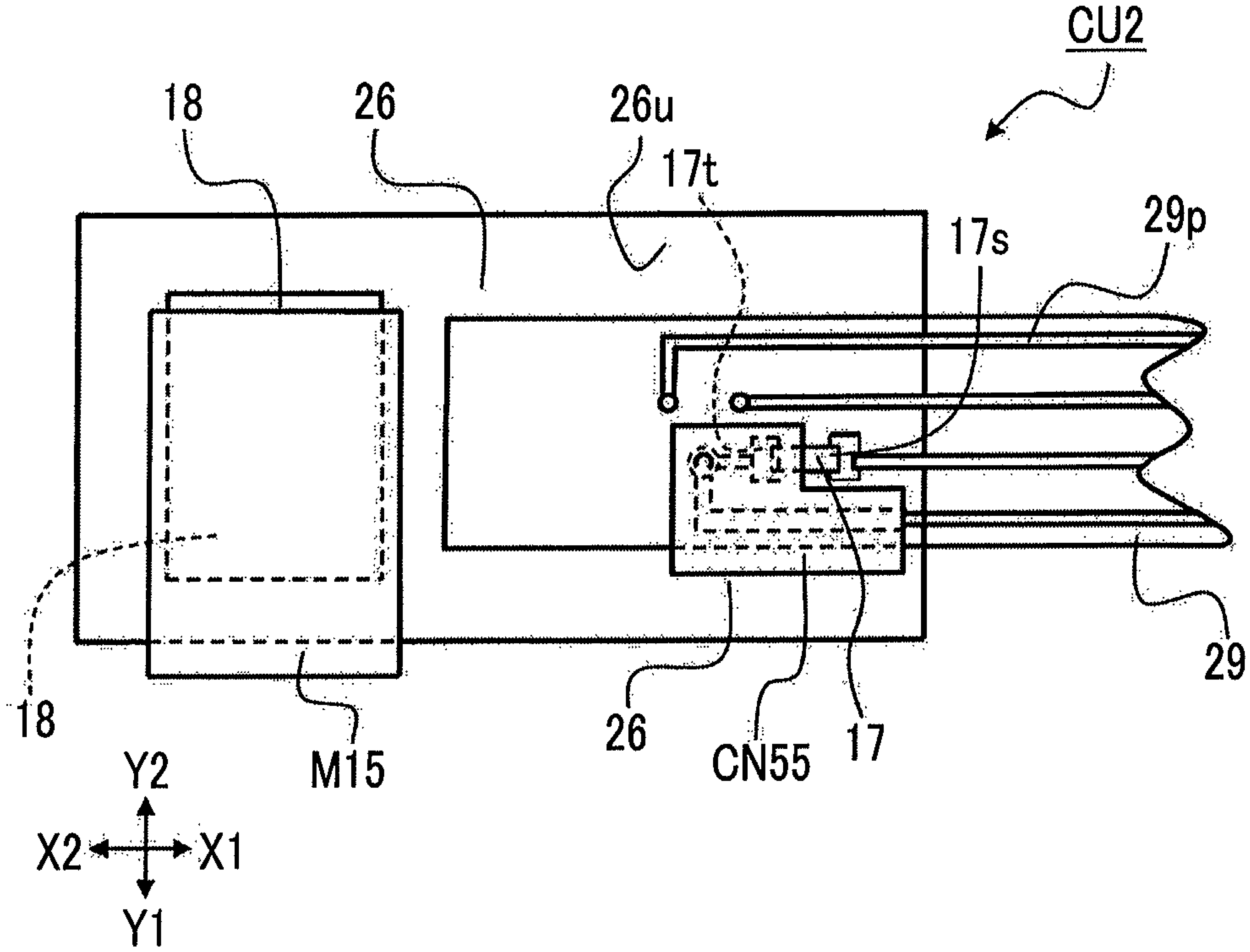


FIG. 12A

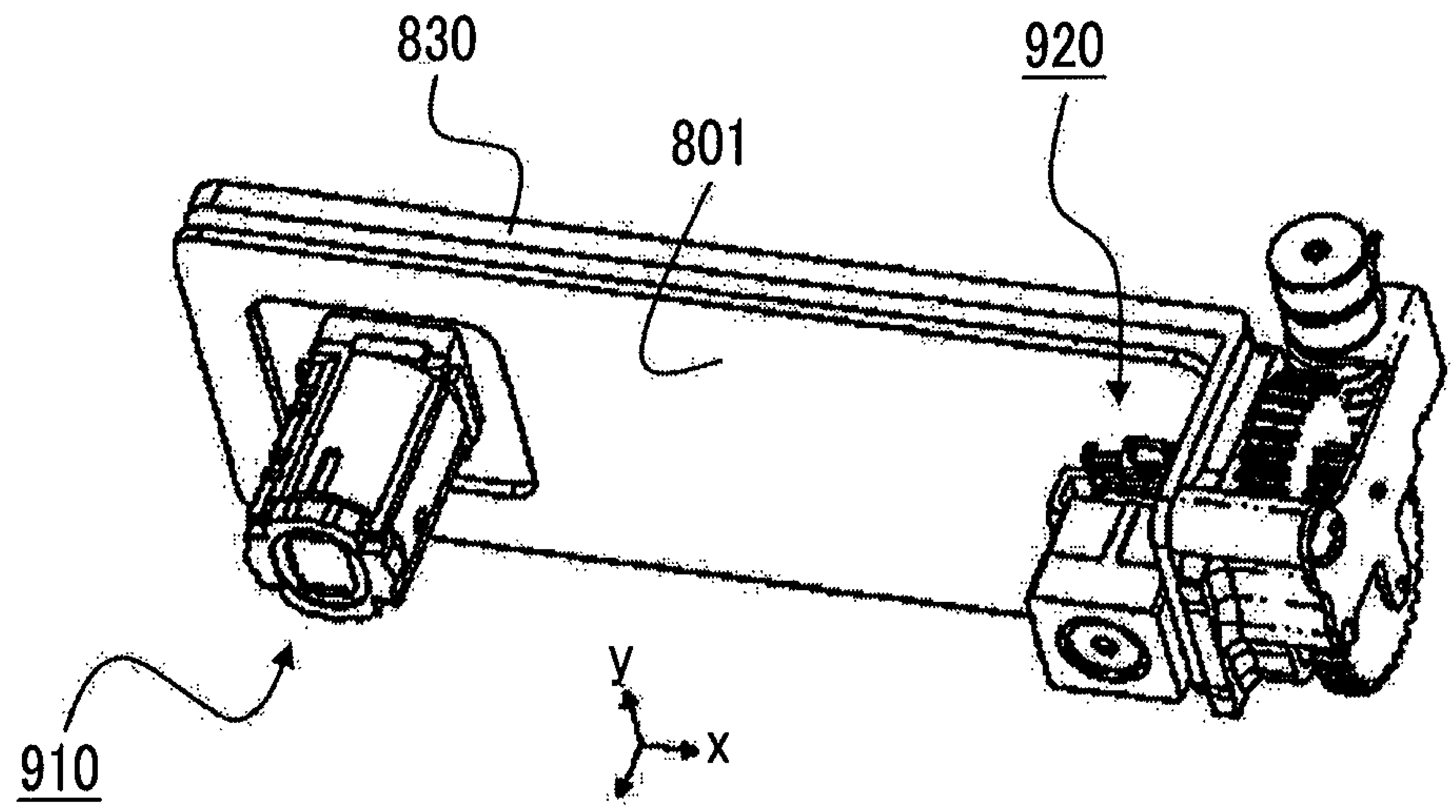


FIG. 12B

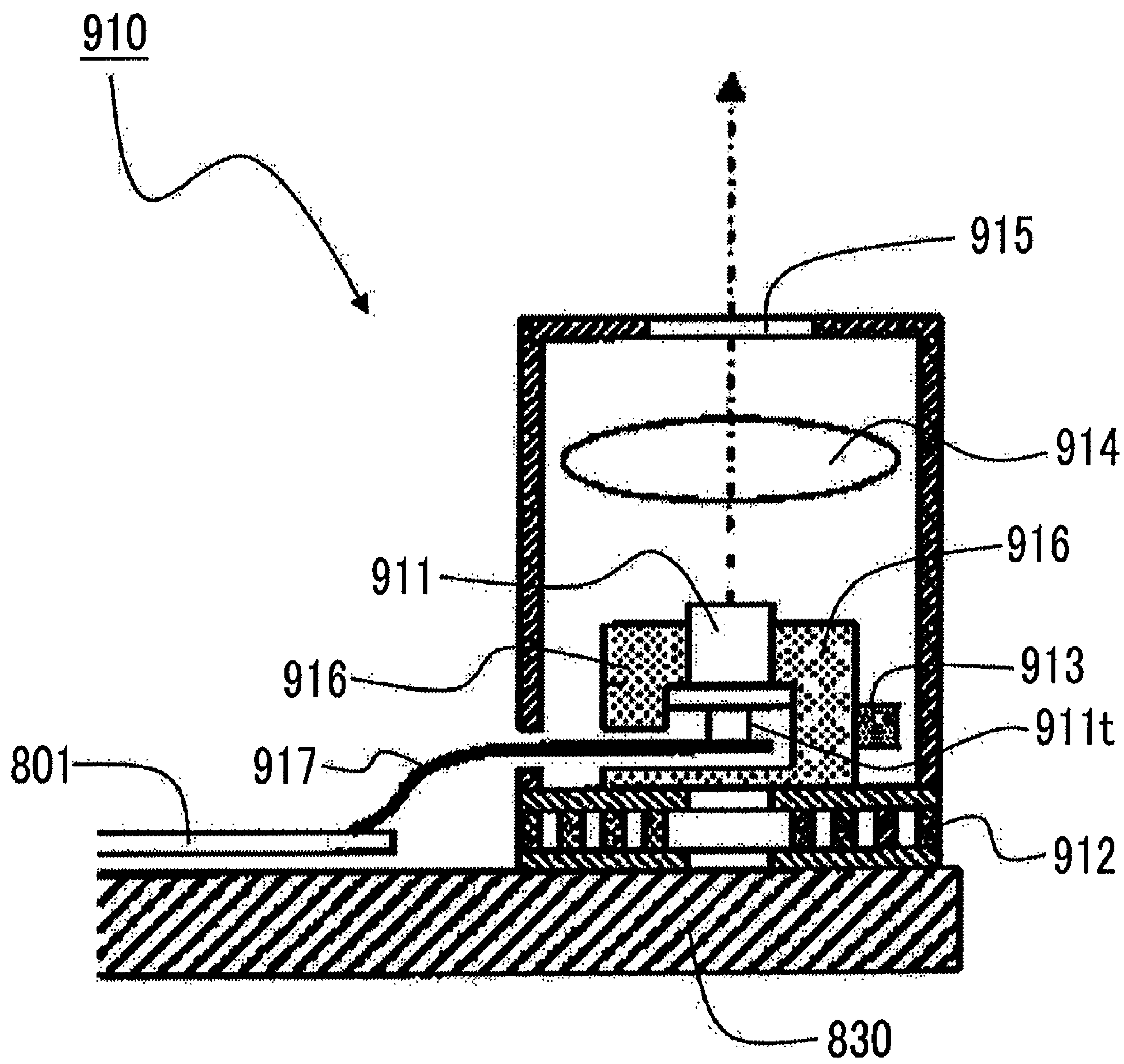
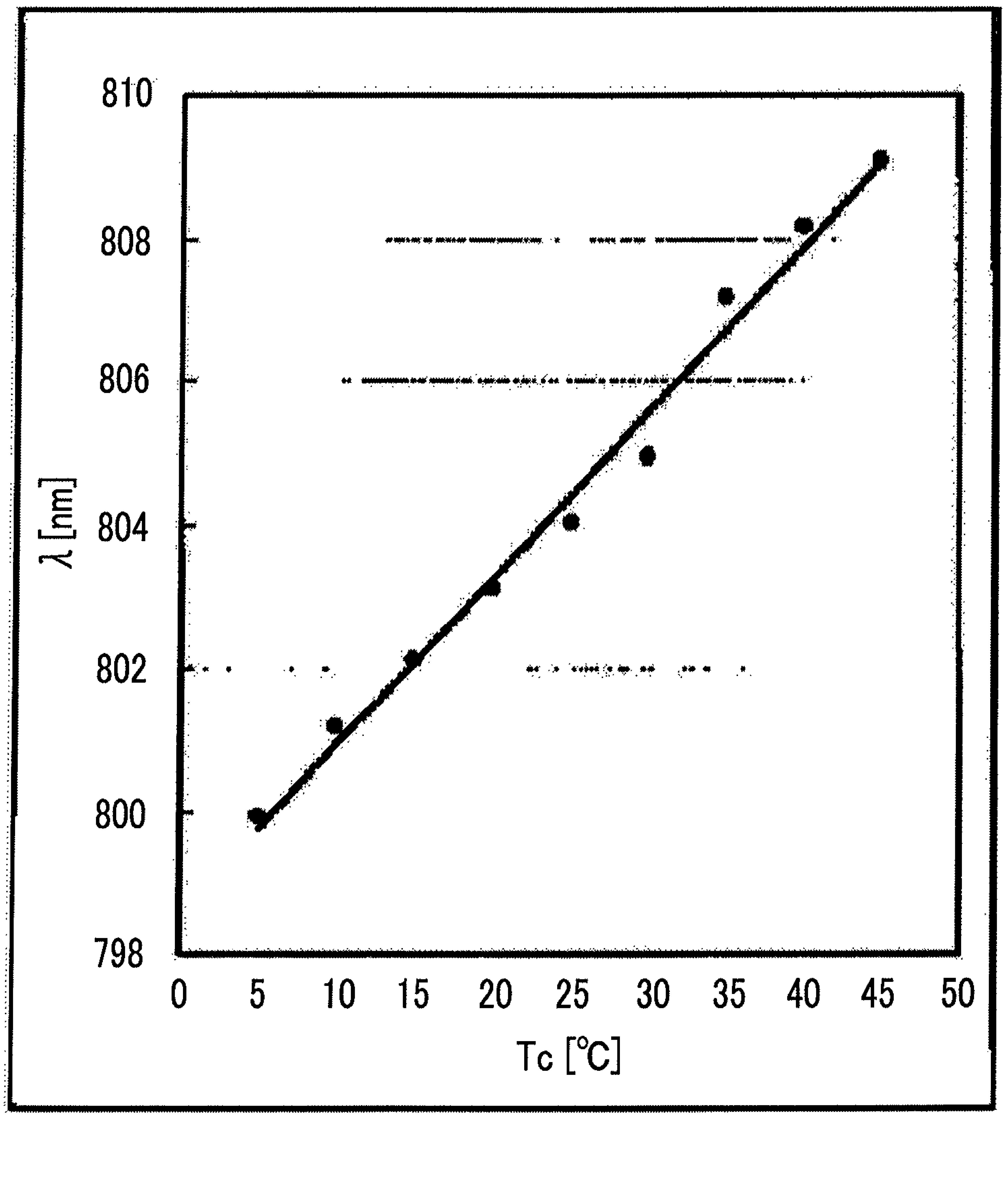


FIG. 13



VIDEO DISPLAY DEVICE

CLAIM OF PRIORITY

This application claims benefit of priority to Japanese Patent Application No. 2013-199773 filed on Sep. 26, 2013, which is hereby incorporated by reference in its entirety.

BACKGROUND

1. Field of the Disclosure

The present disclosure relates to a video display device using a laser beam, and particularly, relates to a video display device which has improved radiation stability of the laser beam and is visually confirmed with a stable display image.

2. Description of the Related Art

In recent years, a laser beam is applied to a wide range of fields such as an optical recording device, a measuring instrument, a printer, a medical instrument, a business machine, or the like which uses characteristics such as a small size, high efficiency, or high directivity. Particularly, recently, a video display device, which radiates the laser beam from the laser beam source to a projection surface such as a screen or a wall using the laser light source and displays an image, is generally known. When the laser beam source is applied to the video display device, it is necessary to stably display a display image which is visually confirmed by an observer, and thus, a stable radiation of the laser beam source is important. Particularly, in the laser beam source, self heat generation is increased according to the radiation of the laser beam, and in most cases, a change in the temperature of the laser beam source due to the heat generation generates instability of the radiation.

Japanese Unexamined Patent Application Publication No. 2011-117849 suggests a device including a configuration which suppresses the change of the temperature due to the heat generation, in, a light source module **910** shown in FIGS. **12**A and **12**B. In related art, FIGS. **12**A and **12**B are views illustrating an object detection device which detects an object inside a target region based on a state of a reflected light when light is projected to a target region, FIG. **12**A is a view showing configurations of a light source module **910** and a light receiving module **920** which are configurations of an optical unit in an information acquisition device of an object detection device, and FIG. **12**B is a cross-sectional configuration view showing the details of the light source module **910**.

The light source module **910** and the light receiving module **920** shown in FIG. **12**A are disposed on a long chassis **830** laterally in an X axis direction. The chassis **830** is a plate shape member, which is configured of a metal having high thermal conductivity, and has a function, which radiates heat of components (here, light source module **910** and light receiving module **920**) disposed on the chassis **830**. Moreover, the light source module **910** shown in FIG. **12**B is configured to include a laser beam source **911** including a semiconductor laser, a laser holder **916** holding a laser beam source **911**, a temperature conditioning element **912** disposed to be adjacent to the laser holder **916**, a temperature sensor **913** disposed to contact a side surface of the laser holder **916**, a projection lens **914** projecting the laser beam outside the cover **915** over the entire target region, and a wiring **917** connected to a terminal **911***t* of the laser beam source **911** and a circuit substrate **801**. The temperature conditioning element **912** uses a thermoelectric element such as a Peltier element, adjusts the temperature of the laser beam source **911** by heating or cooling the laser beam source **911** from information of the temperature sensor **913**, and causes a wavelength of the laser beam emitted from the laser beam source **911** to be maintained at an optimal wavelength.

However, in the related art, since the temperature sensor **913** is disposed to contact the side surface of the laser holder **916**, the temperature sensor indirectly detects the temperature of the laser beam source **911** (CAN) via the laser holder **916**. Accordingly, in the configuration, an error occurs between an actual temperature of the laser beam source **911** and the detected temperature of the temperature sensor **913**. FIG. **13** is a graph showing a relationship between the detected temperature of the temperature sensor **913** and a wavelength of the laser beam according to the laser beam source **911** in the related art. As shown in FIG. **13**, in the laser beam source **911** of the related art, an error occurs between the detected temperature of the temperature sensor **913** and the actual temperature of the laser beam source **911**, and thus, due to the error, an error occurs in the wavelength of the laser beam emitted from the laser beam source **911**. In general, when the laser beam is applied to the video display device, due to the error of the wavelength, instability occurs on a display image visually confirmed by an observer, and thus, in order to suppress the error of the wavelength of the laser beam, correct temperature management is needed.

Moreover, in the laser holder **916** of the related art, it is described that the thermal conductivity is performed by only the member having the thermal conductivity, and thus, if the thermal conductivity is not favorable, a time lag occurs between the actual temperature of the laser beam source **911** and the detected temperature of the temperature sensor **913**. In general, when the laser beam is applied to the video display device, due to time lag, instability occurs on a display image visually confirmed by an observer, and thus, in order to suppress the time lag of the wavelength of the laser beam, a method having improved responsiveness needs.

On the other hand, if the temperature sensor **913** is disposed in the vicinity of the laser beam source **911**, the temperature error or the time lag is decreased. However, in this case, there is a problem in that it is not easy to electrically connect the temperature sensor **913** and the circuit substrate **801** to each other. Actually, in the related art, the connection between the temperature sensor **913** disposed to contact the side surface of the laser holder **916** and the circuit substrate **801** is not disclosed, and thus, it is described that the connection method is not easily performed.

SUMMARY

A video display device allowing an observer to observe video of a display image, includes: a laser beam source module including a laser beam source emitting a laser beam and a laser beam source drive unit supplying power to the laser beam source; and an image generation unit generating a desired display image from the laser beam. The laser beam source module includes: a substrate on which the laser beam source is mounted and which has improved thermal conductivity; a temperature measurement member measuring a temperature of the substrate; a temperature adjustment member contacting the substrate and adjusting the temperature of the substrate; and a circuit substrate electrically connecting the temperature measurement member and the laser beam source. The circuit substrate is disposed on a rear surface opposite to a placement surface on which the laser beam source is placed, the temperature measurement member is

mounted on the circuit substrate, and a portion of the temperature measurement member is connected to the substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a configuration view illustrating a video display device of a first embodiment of the present invention;

FIGS. **2**A and **2**B are configuration views illustrating a laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **2**A is a top perspective view of a unit on which the laser beam source is mounted, and FIG. **2**B is a bottom perspective view of the unit on which the laser beam source is mounted;

FIGS. **3**A and **3**B are configuration views illustrating the laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **3**A is a top view of the unit on which the laser beam source is mounted, and FIG. **3**B is a bottom view of the unit on which the laser beam source is mounted;

FIGS. **4**A and **4**B are configuration views illustrating the laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **4**A is a front view when the module is viewed from an Y2 side shown in FIG. **2**A, and FIG. **4**B is a cross-sectional view taken along line IV-IV shown in FIGS. **3**A and **3**B;

FIGS. **5**A and **5**B are configuration views illustrating the laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **5**A is a side view when the module is viewed from an X1 side shown in FIG. **2**A, and FIG. **5**B is a cross-sectional view taken along line V-V shown in FIGS. **3**A and **3**B;

FIG. **6** is a configuration view illustrating a video display device of a second embodiment of the present invention;

FIGS. **7**A and **7**B are configuration views illustrating a laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **7**A is a top perspective view of a unit on which the laser beam source is mounted, and FIG. **7**B is a bottom perspective view of the unit on which the laser beam source is mounted;

FIGS. **8**A and **8**B are configuration views illustrating the laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **8**A is a top view of the unit on which the laser beam source is mounted, and FIG. **8**B is a bottom view of the unit on which the laser beam source is mounted;

FIGS. **9**A and **9**B are configuration views illustrating the laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **9**A is a front view when the module is viewed from an Y2 side shown in FIG. **7**A, and FIG. **9**B is a cross-sectional view taken along line IX-IX shown in FIGS. **8**A and **8**B;

FIGS. **10**A and **10**B are configuration views illustrating the laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **10**A is a side view when the module is viewed from an X1 side shown in FIG. **7**A, and FIG. **10**B is a cross-sectional view taken along line X-X shown in FIGS. **8**A and **8**B;

FIGS. **11**A and **11**B are views illustrating an modification of the embodiment of the present invention, FIG. **11**A is a bottom view of a first modification of the first embodiment, and FIG. **11**B is a bottom view of a third modification of the first embodiment;

FIGS. **12**A and **12**B are views illustrating an object detection device which detects an object inside a target region based on a state of the reflected light when light is projected to the target region in the related art, FIG. **12**A is a view showing configurations of a light source module and a light receiving module which are configurations of an optical unit in an information acquisition device of an object detection device, and FIG. **12**B is a cross-sectional configuration view showing the details of the light source module; and

FIG. **13** is a graph showing a relationship between the detected temperature of the temperature sensor and a wavelength of the laser beam according to the laser beam source in the related art.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

FIG. **1** is configuration view illustrating a video display device **101** of a first embodiment of the present invention. FIGS. **2**A and **2**B are configuration views illustrating a laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **2**A is a top perspective view of a unit U**1** on which the laser beam source LD is mounted, and FIG. **2**B is a bottom perspective view of the unit U**1** on which the laser beam source LD is mounted. FIGS. **3**A and **3**B are configuration views illustrating the laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **3**A is a top view of the unit U**1** on which the laser beam source LD is mounted, and FIG. **3**B is a bottom view of the unit U**1** on which the laser beam source LD is mounted. FIGS. **4**A and **4**B are configuration views illustrating the laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **4**A is a front view when the module is viewed from an Y2 side shown in FIG. **2**A, and FIG. **4**B is a cross-sectional view taken along line IV-IV shown in FIGS. **3**A and **3**B. FIGS. **5**A and **5**B are configuration views illustrating the laser beam source module according to the video display device of the first embodiment of the present invention, FIG. **5**A is a side view when the module is viewed from an X1 side shown in FIG. **2**A, and FIG. **5**B is a cross-sectional view taken along line V-V shown in FIGS. **3**A and **3**B.

As shown in FIG. **1**, the video display device **101** of the first embodiment of the present invention is mounted on a vehicle, particularly, on an automobile, and is used as a video display device for providing vehicle information with respect to a drive (observer) ST.

As shown in FIG. **1**, the video display device **101** of the first embodiment of the present invention is configured to include a laser beam source module MD**4** that includes the laser beam source LD emitting a laser beam Lc, and an image generation unit **11** that generates a desired display image from the laser beam Lc. Moreover, the video display device **101** includes an optical member OP which introduces video light Lf of the display image to a windshield WS of the vehicle, and a light intensity detection unit **35** which detects light intensity of the video light Lf. Moreover, a video VM of the display image generated by an image generation unit **11** is observed (visually confirmed) through the windshield WS by the observer (driver) ST.

First, a laser beam source module MD**4** of the video display device **101** will be described. As shown in FIG. **1**, the laser beam source module MD**4** is configured to include a unit U**1** that includes a laser beam source LD emitting the laser beam Lc, a laser beam source drive unit **14** that supplies power to the laser beam source LD, and a controller **54** that controls output of the laser beam source drive unit **14** based on detected results of the light intensity detection unit **35**.

In addition, in the unit U**1** of the portion on which the laser beam source LD is mounted, as shown in FIGS. **2**A to **5**B, a substrate **16** having improved thermal conductivity on which the laser beam source LD is placed, a temperature measurement member **17** that measures a temperature of the substrate **16**, a temperature adjustment member **18** that contacts the substrate **16** and adjusts the temperature of the substrate **16**, a heat dissipation member M**15** that is disposed to contact the temperature adjustment member **18**, and a circuit substrate **19** that is electrically connected to the temperature measurement member **17** and the laser beam source LD are provided.

As shown in FIG. **1**, in the first embodiment of the present invention, in the laser beam source LD of the laser beam source module MD**4**, two colors of laser beam sources LD (RLD and GLD) such as red and green are provided. In addition, although it is not shown in detail, in order to emit the red and the green, two kinds of semiconductor laser elements are used. Accordingly, since the semiconductor laser elements are used, the laser beam Lc having high coherence (coherent) can be emitted from the laser beam source LD. Moreover, since the plurality of laser beam sources LD (two kinds and two sources in the first embodiment of the present invention) are provided in this way, the colors of the video VM visually confirmed by the observer ST can be plural, and thus, the video VM can be richly expressed.

Moreover, for example, as the semiconductor laser element, an element emitting light having wavelength of 642 nm or the like is appropriately used in the case of red, and an element emitting light having wavelength of 515 nm or the like is appropriately used in the case of green.

The laser beam source drive unit **14** of the laser beam source module MD**4** is a drive circuit to which an operational amplifier is incorporated, and as shown in FIG. **1**, a laser beam source drive unit **14**R and a laser beam source drive unit **14**G are connected to the laser beam sources LD (RLD and GLD), respectively, power is supplied to respective laser beam sources LD (RLD and GLD), and thus, respective laser beam sources LD (RLD and GLD) are driven.

The controller **54** of the laser beam source module MD**4** controls the output of the laser beam source drive unit **14** (**14**R and **14**G) based on the detected results of the light intensity detection unit **35** (**35**R and **35**G), and as shown in FIG. **1**, the controller is connected to each light intensity detection unit **35** (**35**R and **35**G) and each laser beam source drive unit **14** (**14**R and **14**G). Accordingly, even when the area has different colors and different display images, the output of each laser beam source LD (RLD and GLD) is adjusted by the controller **54**, and light intensity (brightness) of each displayed video VM can be maintained at a desired value. Accordingly, the video VM visually confirmed by the observer ST can be richly expressed. Moreover, the controller **54** includes a function which adjusts the output change of the laser beam source LD according to the change of the temperature by the heat generation of the laser beam source LD in addition to a function which adjusts the output of the laser beam source LD based on the detected results of the light intensity detection unit **35**.

Next, the unit U**1** of the portion on which the laser beam source LD is mounted will be described with reference to FIGS. **2**A to **5**B. Moreover, the laser beam source LD shown in FIGS. **2**A to **5**B is either the red laser beam source LD or the green laser beam source LD, and thus, the unit U**1** having the same configuration is provided with respect to the laser beam source LD having each color.

As shown in FIGS. **2**A to **4**B, the laser beam source LD uses a can type laser beam source in which the semiconductor laser element is mounted in a metal package, and is placed on a placement surface **16***p* of the substrate **16** having improved thermal conductivity. Moreover, the laser beam source LD is electrically connected to a wiring pattern **19***p* of the circuit substrate **19** disposed on a rear surface **16***u* (a surface opposite to the placement surface **16***p*) of the substrate **16**. Moreover, although it is not shown, three pin terminals of the laser beam source LD are connected to wiring patterns **19***p* using solder.

In addition, in the first embodiment of the present invention, a metal substrate in which the substrate **16** and the circuit substrate **19** are integrally formed is used. In general, here, the metal substrate indicates a print wiring substrate having reinforced heat dissipation characteristics or heat resistance, and there are two types such as a metal base substrate in which a circuit is formed on a metal plate and a metal core substrate in which a metal plate is interposed to an inner portion of the substrate. In addition, as a metal material of the metal plate, a material having improved thermal conductivity such as aluminum (Al) or copper (Cu) is selected. In the first embodiment of the present invention, as shown in FIGS. **4**B and **5**B, the metal core substrate in which the metal core (metal plate) **16***c* is interposed to an inner portion of the substrate **16** is used, a print wiring formed on the rear surface **16***u* of the substrate **16** is used as the circuit substrate **19**. Accordingly, the circuit substrate **19** having the wiring pattern **19***p* for supplying power, transmitting signal, or the like, and the substrate **16** for thermal conduction can be easily formed, and the circuit substrate **19** and the substrate **16** can be easily connected to each other. In addition, since the metal core substrate is used in the first embodiment of the present invention, the wiring can be also formed on the placement surface **16***p* side of the substrate **16**, and thus, even when the laser beam source is not a dip type laser beam source LD used in the first embodiment of the present invention and is a surface mounting type laser beam source LD, the surface mounting type laser beam source can be mounted on the placement surface **16***p* side of the substrate **16** as it is.

In addition, as shown in FIGS. **2**A, **3**A, and **4**A, the metal package of the laser beam source LD and a metal layer **16***m* provided on the placement surface **16***p* of the substrate **16** are connected by spot welding (Wd shown in the drawings), and thus, the laser beam source LD is fixed to the substrate **16**. Moreover, as shown in FIGS. **4**B and **5**B, since the metal layer **16***m* and the metal core **16***c* are integrated with each other, the heat of the laser beam source LD is easily conducted to the metal core **16***c*. Moreover, a resist layer **16***r* is provided on the surface of the placement surface **16***p* other than a portion on which the laser beam source LD is placed, and thus, the surface of the placement surface other than this portion is protected from an external environment.

In addition, as shown in FIG. **3**A, a connector CN**1** for electric connection with respect to the outer portion of the unit U**1** is mounted on the circuit substrate **19**. In addition, although it is not shown, the laser beam source LD and the laser beam source drive unit **14** are connected to each other via a wiring pattern **19***p* and the connector CN**1**. Moreover, the wiring pattern **19***p* and the terminal of the connector CN**1** are connected to each other by solder.

In addition, as shown in FIGS. **2**B, **3**B, and **5**B, the temperature measurement member **17** for measuring the temperature of the substrate **16** is mounted on the circuit substrate **19**, and one terminal portion **17***s* of the terminal of the temperature measurement member **17** is electrically connected to a wiring pattern $19p_1$ of the circuit substrate **19**. Moreover, at least a portion of the temperature measurement member **17** other than the one terminal portion **17***s* contacts the metal core **16***c* of the substrate **16** via a wiring pattern $19p_2$, and as shown in FIG. **5**B, the other terminal portion **17***t* of the terminal of the temperature measurement member **17** is electrically connected to the metal core **16***c* of the substrate **16** via the wiring pattern **19***p_2*. Accordingly, in the contact portion between the metal core **16***c* of the substrate **16**, to which the heat of the laser beam source LD is easily conducted, and the temperature measurement member **17**, the temperature is securely detected, and thus, the temperature of the laser beam source LD can be correctly measured.

In addition, the circuit substrate **19** is disposed on the rear surface **16***u* opposite to the placement surface **16***p* on which the laser beam source LD is placed, the temperature measurement member **17** is mounted on the circuit substrate **19**, and thus, the laser beam source LD and the temperature measurement member **17**, and the circuit substrate **19** are electrically connected to each other only on the rear surface **16***u* of the substrate **16**. As described above, the connection is easily performed, and thus, a problem of the related art, in which it is difficult to electrically connect the temperature sensor **913** and the circuit substrate **801**, can be solved.

Moreover, the wiring pattern **19***p_2* connected to the substrate **16** is connected to a grand terminal G**1** (refer to FIG. **3**A) of the connector CN**1**, and although it is not shown, the substrate **16** and the other terminal portion **17***t* of the temperature measurement member **17** are grounded to the outside via the wiring pattern **19***p_2* of the circuit substrate **19** and the grand terminal G**1** of the connector CN**1**. Accordingly, the wiring to the other terminal portion **17***t* can be omitted. Therefore, the temperature measurement member **17** can be easily mounted, and the laser beam source module MD**4** can be easily manufactured. In addition, the resist layer **19***r* is provided on the surface of the circuit substrate **19**, and thus, is protected from the external environment.

In addition, in the first embodiment of the present invention, as the temperature measurement member **17**, a chip type thermistor is used. Therefore, a surface mounting of the temperature measurement member can be performed on the circuit substrate **19**. According to the effect, unlike the related art, difficulty of the connection between the temperature sensor **913** disposed to contact a side surface of the laser holder **916** and the circuit substrate **801** can be resolved. Accordingly, the laser beam source module MD**4** can be easily manufactured.

As shown in FIGS. **2**A to **5**B, the temperature adjustment member **18** which adjusts the temperature of the substrate **16** is provided on the rear surface **16***u* of the substrate **16**. As the temperature adjustment member **18**, a Peltier element which is a semiconductor element using Peltier effects is appropriately used. Moreover, although it is not shown in detail, one surface side (Z1 side in FIGS. **4**A and **4**B) of the temperature adjustment member **18** is connected to the metal core **16***c* of the substrate **16** via the metal layer **16***n*. In addition, the cooling effect on the metal core **16***c* is adjusted by the temperature adjustment member **18**, and thus, the temperature of the substrate **16** can be adjusted. Accordingly, the temperature of the laser beam source LD can be adjusted via the substrate **16** (metal core **16***c*) having improved thermal conductivity based on the temperature detected by the temperature measurement member **17**. Therefore, instability of the radiation of the laser beam Lc due to the change of the temperature can be suppressed, and thus, the display image visually confirmed by the observer ST can be stably displayed.

In addition, as shown in FIGS. **2**A to **5**B, the heat dissipation member M**15** is disposed on the rear surface **16***u* of the substrate **16** to contact the other surface side (Z2 side in FIGS. **4**A and **4**B) of the temperature adjustment member **18**. As the heat dissipation member M**15**, a heat dissipation plate (so-called heat sink) using a material having improved thermal conductivity such as aluminum (Al) or copper (Cu) is appropriately used. Accordingly, the heat dissipation from the temperature adjustment member **18** can be more effectively performed. Therefore, the temperature of the laser beam source LD can be securely adjusted with improved responsiveness via the substrate **16** having improved thermal conductivity.

Finally, the image generation unit **11**, the optical member OP, and the light intensity detection unit **35** of the video display device **101** will be described.

As shown in FIG. **1**, the image generation unit **11** of the video display device **101** is configured to include a holographic optical element **31** which diffracts the laser beam Lc to make video light Lf, a driver **51** which drives the holographic optical element **31**, and a central processing unit **71** which prepares a "hologram pattern".

The holographic optical element **31** of the image generation unit **11** has a function which diffracts the laser beam Lc from the laser beam source LD to make the video light Lf. Specifically, in the first embodiment of the present invention, a phase modulation type liquid crystal on silicon (LCOS) is used, coherent light (laser beam Lc) is radiated to the "hologram pattern" written to the phase modulation type LCOS, and thus, diffracted light is generated and is emitted as the video light Lf through a Fourier lens FL**1** shown in FIG. **1**. In addition, the intensity and the phase of the light are recorded on the "hologram pattern".

In addition, as shown in FIG. **1**, the driver **51** is connected to the holographic optical element **31**, and the driver **51** has a function which writes the "hologram pattern" prepared by the central processing unit **71** to the phase modulation type LCOS as necessary. Moreover, in the first embodiment of the present invention, a desired display image is generated using the holographic optical element **31**, the output of the laser beam source LD can be matched for each display image of the displayed video VM, and thus, the output adjustment of the laser beam source drive unit **14** can be finely performed.

The optical member OP of the video display device **101** is mainly configured of optical components which introduce the video light Lf from the holographic optical element **31** to the windshield WS of the vehicle, and in the first embodiment of the present invention, as shown in FIG. **1**, the optical member includes planar mirrors (**12** and **22**) which change the optical path of the laser beam Lc, an optical lens **32** which collects or collimates the light, a slitter **52** which defines the display range of a display screen, a diffuser **13** which diffuses the video light Lf, and an optical filter F**5** which is disposed on the optical path of the video light Lf. Moreover, the optical member also includes an optical lens **42** which collects or collimates the laser beam Lc from the laser beam source LD.

The planar mirrors (**12** and **22**), the optical lens **32**, and the optical lens **42** of the optical member OP use the optical components which are generally used, and do not have particular specifications. Moreover, instead of the planar mirrors (**12** and **22**), a curved mirror may be used. Moreover, the present invention is not limited to the combination of the planar mirrors (**12** and **22**) or the optical lenses (**32** and **42**) shown in FIG. **1**.

The slitter **52** of the optical member OP passes through most of the radiation range of the video light Lf, and the range corresponding to the video light Lf passing through the slitter becomes the display image of the video VM (refer to FIG. **1**) which is visually confirmed by the observer ST, that is, the display image.

As shown in FIG. **1**, the diffuser **13** of the optical member OP is disposed at the rear side (an emitting direction of the video light Lf) of the slitter **52** in the optical path of the video light Lf, and diffuses the transmitted video light Lf. Moreover, a drive unit **13***d* which drives the diffuser **13** is connected to the diffuser **13** and rotates the diffuser **13**. Accordingly, directivity of the video light Lf which is a coherent laser beam Lc is decreased. Therefore, a speckle pattern due to the coherent light can be decreased, and thus, quality of the video VM which is visually confirmed by the observer ST can be improved. Here, the speckle pattern means a fine interference fringe which is generated by interference of scattered lights scattered at each portion on an irradiated object when light having high coherence (coherent) abuts the irradiated object and is scattered. Moreover, in the first embodiment of the present invention, the diffuser **13** is rotated. However, the present invention is not limited to this, and for example, the diffuser may be vibrated.

The light intensity detection unit **35** of the video display device **101** detects the light intensity of the video light Lf, and as shown in FIG. **1**, is disposed in the vicinity of the slitter **52**, and two of the light intensity detection units **35**R and the light intensity detection unit **35**G are provided to correspond two of the laser beam source RLD and the laser beam source GLD. Moreover, with respect to the video light Lf radiated to the light intensity detection unit **35**R and the light intensity detection unit **35**G, the intensity for each color of the red and the green is separately detected. As the light intensity detection unit **35**, a photodiode (PD) is appropriately used.

In the video display device **101** of the first embodiment of the present invention having the above-described configuration, the effects will be described below.

In the video display device **101** of the first embodiment of the present invention, the laser beam source LD is placed on the substrate **16** having improved thermal conductivity, the temperature measurement member **17** detecting the temperature of the substrate **16** and the temperature adjustment member **18** adjusting the temperature of the substrate **16** are provided, and a portion of the temperature measurement member **17** is connected to the substrate **16**. Accordingly, the temperature of the laser beam source LD can be detected via the substrate **16** having improved thermal conductivity, and the temperature of the substrate **16** can be adjusted by the temperature adjustment member **18** based on the detected temperature. Therefore, the temperature of the laser beam source LD can be adjusted via the substrate **16** having improved thermal conductivity. Accordingly, instability of the radiation of the laser beam Lc due to the change of the temperature can be suppressed, and the display image visually confirmed by the observer ST can be stably displayed.

Moreover, since at least a portion of the temperature measurement member **17** other than the one terminal portion **17***s* contacts the substrate **16**, the detection of the temperature of the substrate **16** can be securely performed at the contact portion, and thus, the temperature of the laser beam source LD mounted on the substrate **16** can be correctly measured. Accordingly, the instability of the radiation of the laser beam Lc due to the change of the temperature can be further suppressed. Moreover, the other terminal portion **17***t* of the terminal of the temperature measurement member **17** is electrically connected to the substrate **16** to be grounded, and thus, the wiring to the other terminal portion **17***t* can be omitted. Accordingly, the temperature measurement member **17** can be easily mounted, and thus, the laser beam source module MD**4** and the video display device **101** can be easily manufactured.

Moreover, the substrate **16** and the circuit substrate **19** are integrally formed using the metal substrate, and thus, the circuit substrate **19** having the wiring pattern **19***p* for supplying power, transmitting signal, or the like, and the substrate **16** for performing thermal conduction can be easily formed, and the circuit substrate **19** and the substrate **16** can be easily connected to each other. In addition, in the first embodiment of the present invention, since the metal core substrate is used, the wiring can be also formed on the placement surface **16***p* side of the substrate **16**, and thus, even when the laser beam source is not a dip type laser beam source LD used in the first embodiment of the present invention and is a surface mounting type laser beam source LD, the surface mounting type laser beam source can be mounted on the placement surface **16***p* side of the substrate **16** as it is.

In addition, the temperature measurement member **17** is a chip type thermistor, and thus, the surface mounting of the temperature measurement member can be performed on the circuit substrate **19**. Accordingly, compared to the configuration of the related art, the laser beam source module MD**4** and the video display device **101** can be more easily manufactured.

Moreover, the laser beam source module MD**4** includes the heat dissipation member M**15** disposed to contact the temperature adjustment member **18**, and thus, heat dissipation from the temperature adjustment member **18** can be effectively performed. Accordingly, the temperature of the laser beam source LD can be securely adjusted with improved responsiveness via the substrate **16** having improved thermal conductivity.

FIG. **6** is a configuration view illustrating a video display device **102** of a second embodiment of the present invention. FIGS. **7**A and **7**B are configuration views illustrating a laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **7**A is a top perspective view of a unit U**2** on which the laser beam source LD is mounted, and FIG. **7**B is a bottom perspective view of the unit U**2** on which the laser beam source LD is mounted. Moreover, for ease of description, a thermal conduction member N**55** is shown by a dashed line. FIGS. **8**A and **8**B are configuration views illustrating the laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **8**A is a top view of the unit U**2** on which the laser beam source LD is mounted, and FIG. **8**B is a bottom view of the unit U**2** on which the laser beam source LD is mounted. FIGS. **9**A and **9**B are configuration views illustrating the laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **9**A is a front view when the module is viewed from an Y**2** side shown in FIG. **7**A, and FIG. **9**B is a cross-sectional view taken along line IX-IX shown in FIGS. **8**A and **8**B. FIGS. **10**A and **10**B are configuration views illustrating the laser beam source module according to the video display device of the second embodiment of the present invention, FIG. **10**A is a side view when the module is viewed from an X**1** side shown in FIG. **7**A, and FIG. **10**B is a cross-sectional view taken along line X-X shown in FIGS. **8**A and **8**B. Moreover, the video display device **102** of the second embodiment is different from that of the first embodiment in that an image generation unit **21** and the unit U**2** on which the laser beam source LD is mounted are different from each other. In addition, the same reference numerals are assigned to the same configurations as the first embodiment, and the description thereof is omitted.

As shown in FIG. **6**, the video display device **102** of the second embodiment of the present invention is mounted on a laser projector for office work, or the like, and is used as a video display device which provides a video with respect to a viewer (observer) ST.

As shown in FIG. **6**, the video display device **102** of the second embodiment of the present invention is configured to include a laser beam source module MJ**4** which includes a laser beam source LD emitting the laser beam Lc, and the image generation unit **21** which generates a desired display image from the laser beam Lc. Moreover, the video display device **102** includes an optical member OP which introduces the video light Lf of the display image to a screen SC, and the light intensity detection unit **35** which detects light intensity of the laser beam Lc. In addition, the video VM of the display image generated by the image generation unit **21** is projected to the screen SC, and is observed (is visually confirmed) by the observer (viewer) ST.

First, the laser beam source module MJ**4** of the video display device **102** will be described. As shown in FIG. **6**, the laser beam source module MJ**4** is configured to include the unit U**2** that includes the laser beam source LD emitting the laser beam Lc, a laser beam source drive unit **24** that supplies power to the laser beam source LD, and the controller **54** that controls output of the laser beam source drive unit **24** based on detected results of the light intensity detection unit **35**.

In addition, in the unit U**2** of the portion on which the laser beam source LD is mounted, as shown in FIGS. **2**A to **5**B, a substrate **26** having improved thermal conductivity on which the laser beam source LD is placed, the temperature measurement member **17** that measures the temperature of the substrate **26**, the thermal conduction member N**55** having improved thermal conductivity, the temperature adjustment member **18** that contacts the substrate **26** and adjusts the temperature of the substrate **26**, the heat dissipation member M**15** that is disposed to contact the temperature adjustment member **18**, and a circuit substrate **29** that is electrically connected to the temperature measurement member **17** and the laser beam source LD are provided.

As shown in FIG. **6**, in the second embodiment of the present invention, in the laser beam source LD of the laser beam source module MJ**4**, three colors of laser beam sources LD (RLD, GLD, and BLD) such as red, green, and blue are provided. Moreover, although it is not shown in detail, in order to emit the red, the green, and blue, three kinds of semiconductor laser elements are used. Accordingly, since the semiconductor laser elements are used, the laser beam Lc having high coherence (coherent) can be emitted from the laser beam source LD. Moreover, since the plurality of laser beam sources LD (three kinds and three sources in the second embodiment of the present invention) are provided in this way, the colors of the video VM visually confirmed by the observer ST can be in plural, and thus, the video VM can be richly expressed.

Moreover, for example, as the semiconductor laser element, an element emitting light having wavelength of 642 nm or the like is appropriately used in the case of red, an element emitting light having wavelength of 515 nm or the like is appropriately used in the case of green, and an element emitting light having wavelength of 445 nm or the like is appropriately used in the case of blue.

The laser beam source drive unit **24** of the laser beam source module MJ**4** is a drive circuit to which an operational amplifier is incorporated, and as shown in FIG. **6**, a laser beam source drive unit **24**R, a laser beam source drive unit **24**G, and a laser beam source drive unit **24**B are connected to the laser beam sources LD (RLD, GLD, and BLD), respectively, power is supplied to respective laser beam sources LD (RLD, GLD, and BLD), and thus, respective laser beam sources LD (RLD, GLD, and BLD) are driven.

Similar to the first embodiment, the controller **54** of the laser beam source module MJ**4** controls the output of the laser beam source drive unit **24** (**24**R, **24**G, and **24**B) based on the detected results of the light intensity detection unit **35** (**35**R, **35**G, and **35**B), and as shown in FIG. **6**, the controller is connected to each light intensity detection unit **35** (**35**R, **35**G, and **35**B) and each laser beam source drive unit **24** (**24**R, **24**G, and **24**B). Accordingly, even when the area has different colors and different display images, the output of each laser beam source LD (RLD, GLD, and BLD) is adjusted by the controller **54**, and light intensity (brightness) of each displayed video VM can be maintained at a desired value. Therefore, the video VM visually confirmed by the observer ST can be richly expressed. Moreover, the controller **54** includes a function which adjusts the output change of the laser beam source LD according to the change of the temperature by the heat generation of the laser beam source LD in addition to a function which adjusts the output of the laser beam source LD based on the detected results of the light intensity detection unit **35**.

Next, the unit U**2** of the portion on which the laser beam source LD is mounted will be described with reference to FIGS. **7**A to **10**B. Moreover, the laser beam source LD shown in FIGS. **7**A to **10**B is any one of the red laser beam source LD, the green laser beam source LD, and the blue laser beam source LD, and thus, the unit U**2** having the same configuration is provided with respect to the laser beam source LD having each color.

Similar to the first embodiment, as shown in FIGS. **7**A to **9**B, the laser beam source LD uses a can type laser beam source in which the semiconductor laser element is mounted in the metal package, and is placed on a placement surface **26***p* of the substrate **26** having improved thermal conductivity. Moreover, the laser beam source LD is electrically connected to a wiring pattern **29***p* of the circuit substrate **29** disposed on a rear surface **26***u* (a surface opposite to the placement surface **26***p*) of the substrate **26**. In addition, three pin terminals of the laser beam source LD are connected to wiring patterns **29***p* using solder.

As shown in FIGS. **7**A, **8**A, and **9**B, the substrate **26** is formed in a rectangular plate shape using a material having improved thermal conductivity such as aluminum (Al) or copper (Cu). In addition, the laser beam source LD is placed on the substrate **26**, the placement surface **26***p* of the substrate **26** and the metal package of the laser beam source LD are connected to each other by spot welding (Wd shown in the drawings), and the laser beam source LD is fixed to the substrate **26**. Accordingly, the heat generated due to the laser beam source LD can be easily conducted to the substrate **26**.

The circuit substrate **29** is a flexible printed circuit (FPC) which is widely used in general, and as shown in FIGS. **7**B and **8**B, the circuit substrate **29** is disposed on the rear surface **26***u* (the surface opposite to the placement surface **26***p*) of the substrate **26** and is electrically connected to the wiring pattern **29***p* of the circuit substrate **29** and three pin terminals of the laser beam source LD. Moreover, although it is not shown, the circuit substrate **29** is extended for electric connection between the unit U**2** and the outside, and for example, the laser beam source LD and the laser beam source drive unit **24** are connected to each other via the wiring pattern **29***p*.

Moreover, the circuit substrate **29** is the flexible printed circuit, and thus, the flexible printed circuit can be disposed on the rear surface **26***u* side of the substrate **26** with a certain degree of freedom. For example, in a case where the mounting angle of the laser beam source LD is changed due to optical-axis alignment or the like of the laser beam source LD, even when some misalignment occurs in the disposition of three pin terminals of the laser beam source LD on the rear surface **26***u* side of the substrate **26**, the flexible printed circuit can be disposed to match the misalignment. Accordingly, the laser beam source module MJ**4** can be more easily manufactured.

In addition, as shown in FIGS. **7**B, **8**B, and **10**B, the temperature measurement member **17** for measuring the temperature of the substrate **26** is mounted on the circuit substrate **29** and is electrically connected to the wiring pattern **29***p* of the circuit substrate **29**. Accordingly, the laser beam source LD and the temperature measurement member **17**, and the circuit substrate **29** are electrically connected to each other only on the rear surface **26***u* of the substrate **26**. As described above, the connection is easily performed, and thus, a problem of the related art, in which it is difficult to electrically connect the temperature sensor **913** and the circuit substrate **801**, can be solved.

In addition, also in the second embodiment of the present invention, as the temperature measurement member **17**, a chip type thermistor is used. Therefore, a surface mounting of the temperature measurement member can be performed on the circuit substrate **29**. According to the effect, unlike the related art, difficulty of the connection between the temperature sensor **913** disposed to contact a side surface of the laser holder **916** and the circuit substrate **801** can be solved. Accordingly, the laser beam source module MJ**4** can be easily manufactured.

Moreover, as shown in FIG. **8**B, the thermal conduction member N**55** having improved thermal conductivity is disposed on the rear surface **26***u* side of the substrate **26**, the thermal conduction member N**55** covers a portion of the temperature measurement member **17** other than the other terminal portion **17***t* and the one terminal portion **17***s* of the terminal of the temperature measurement member **17**, and covers a portion of the circuit substrate **29** and a portion of the substrate **26** over the circuit substrate **29** and the substrate **26**. Accordingly, a portion of the temperature measurement member **17** and the substrate **26** are connected to each other via the thermal conduction member N**55**. Therefore, the detection of the temperature of the substrate **26** can be securely performed by the temperature measurement member **17** via the thermal conduction member N**55**.

Moreover, in the second embodiment of the present invention, the thermal conduction member N**55** uses a solder member. Accordingly, when the electric connection between the temperature measurement member **17** and the wiring pattern **29***p* of the circuit substrate **29** is performed, the temperature measurement member **17** and the substrate **26** can be simultaneously connected to each other. Therefore, the laser beam source module MJ**4** can be easily manufactured. In addition, the solder member is appropriately used as the thermal conduction member N**55**. However, a thermal conductive adhesive material may be used as the thermal conduction member N**55**.

In addition, as shown in FIGS. **7**A to **10**B, the temperature adjustment member **18** which adjusts the temperature of the substrate **26** is provided on the rear surface **26***u* of the substrate **26**. Similar to the first embodiment, as the temperature adjustment member **18**, a Peltier element which is a semiconductor element using Peltier effects is appropriately used. In addition, a cooling effect on the substrate **26** is adjusted by the temperature adjustment member **18**, and thus, the temperature of the substrate **26** can be adjusted. Accordingly, the temperature of the laser beam source LD can be adjusted via the substrate **26** having improved thermal conductivity based on the temperature detected by the temperature measurement member **17**. Therefore, instability of the radiation of the laser beam Lc due to the change of the temperature can be suppressed, and thus, the display image visually confirmed by the observer ST can be stably displayed.

Moreover, similar to the first embodiment of the present invention, as shown in FIGS. **7**A to **10**B, the heat dissipation member M**15** is disposed on the rear surface **26***u* of the substrate **26** to contact the other surface side (Z2 side in FIGS. **9**A and **9**B) of the temperature adjustment member **18**. As the heat dissipation member M**15**, a heat dissipation plate (so-called heat sink) using a material having improved thermal conductivity such as aluminum (Al) or copper (Cu) is appropriately used. Accordingly, the heat dissipation from the temperature adjustment member **18** can be more effectively performed. Therefore, the temperature of the laser beam source LD can be securely adjusted with improved responsiveness via the substrate **26** having improved thermal conductivity.

Finally, the image generation unit **21**, the optical member OP, and the light intensity detection unit **35** of the video display device **102** will be described.

As shown in FIG. **6**, the image generation unit **21** of the video display device **102** is configured to include a mirror unit **41** which combines three laser beams Lc and emits the beams, a drive scanning mirror **61** that scans the laser beam Le emitted from the mirror unit **41** to make the video light Lf, a signal generation unit **81** that generates a drive signal having a predetermined frequency, and a mirror drive unit **91** that drives the drive scanning mirror **61** based on the drive signal generated by the signal generation unit **81**.

For example, the mirror unit **41** of the image generation unit **21** is a diachronic mirror or the like which transmits the light having a specific wavelength and reflects the light having wavelengths other than the above-mentioned wavelength, combines the laser beam Lc of each color from the plurality of laser beams Lc to make the laser beam Le having one optical axis, and emits the laser beam Le to the drive scanning mirror **61**.

The drive scanning mirror **61** of the image generation unit **21** has a function as scanning means for reflecting the laser beam Le, which is emitted from the laser beam source LD and is combined by the mirror unit **41**, in a two-dimensional direction, by electromagnetic drive, and for projecting and scanning the video light Lf to the screen SC. The drive scanning mirror **61** appropriately uses a MEMS mirror which uses a Micro Electro Mechanical System (MEMS) technology. The MEMS mirror is a minute device which is manufactured by collecting mechanical mechanisms and electric circuits on a silicon wafer using a micromachining technology, and a reduction in the overall size of the apparatus can be improved using the MEMS mirror.

The signal generation unit **81** of the image generation unit **21** generates a drive signal for driving the drive scanning mirror **61** in a main scanning direction and a sub scanning direction orthogonal to the main scanning direction according to the control of the controller **54**. Particularly, the signal generation unit **81** functions as scan signal generating means, generates a pulse signal that is a drive signal by which the drive scanning mirror **61** performs a main scanning on the laser beam Le in a right-left direction, and generates a drive signal by which the drive scanning mirror **61** performs a sub scanning on the laser beam Le in an up-down direction.

The mirror drive unit **91** of the image generation unit **21** is connected to the drive scanning mirror **61**, and drives the drive scanning mirror **61** based on the drive signal generated in the signal generation unit **81**. Particularly, the mirror drive unit **91** functions as driving means for reciprocating the drive scanning mirror **61** in the main scanning direction (right-left direction) according to the pulse signal generated in the signal generation unit **81**.

The optical member OP of the video display device **102** is mainly configured of an optical component which introduces the laser beam Le emitted from the mirror unit **41** to the drive scanning mirror **61**, and in the second embodiment of the present invention, as shown in FIG. **6**, includes an optical lens **62** which collects or collimates the light. Moreover, the optical lens **62** of the optical member OP is an optical component, which is generally used, and does not have a particular specification.

The light intensity detection unit **35** of the video display device **102** detects the light intensity of the video light Lf, and as shown in FIG. **6**, is disposed in the vicinity of the laser beam source LD, and three of the light intensity detection unit **35**R, the light intensity detection unit **35**G, and the light intensity detection unit **35**B are provided according to three of the laser beam source RLD, the laser beam source GLD, and the laser beam source BLD. Moreover, the light intensity detection unit separately detects the intensity for each color of the red, the green, and the blue with respect to the laser beam Lc radiated to the light intensity detection unit **35**R, the light intensity detection unit **35**G, and the light intensity detection unit **35**B. The light intensity detection unit **35** appropriately uses a photodiode (PD).

In the video display device **102** of the second embodiment of the present invention having the above-described configuration, the effects will be described below.

In the video display device **102** of the second embodiment of the present invention, the laser beam source LD is placed on the substrate **26** having improved thermal conductivity, the temperature measurement member **17** detecting the temperature of the substrate **26** and the temperature adjustment member **18** adjusting the temperature of the substrate **26** are provided, and a portion of the temperature measurement member **17** is connected to the substrate **26**. Accordingly, the temperature of the laser beam source LD can be detected via the substrate **26** having improved thermal conductivity, and the temperature of the substrate **26** can be adjusted by the temperature adjustment member **18** based on the detected temperature. Therefore, the temperature of the laser beam source LD can be adjusted via the substrate **26** having improved thermal conductivity. Accordingly, instability of the radiation of the laser beam Lc due to the change of the temperature can be suppressed, and the display image visually confirmed by the observer ST can be stably displayed.

Moreover, since a portion of the temperature measurement member **17** and the substrate **26** are connected to each other via the thermal conduction member N**55**, the detection of the temperature of the substrate **26** can be securely performed by the temperature measurement member **17** via the thermal conduction member N**55**. Accordingly, the instability of the radiation of the laser beam Lc due to the change of the temperature can be further suppressed.

In addition, since the thermal conduction member N**55** is a solder member, when the electric connection between the temperature measurement member **17** and the wiring pattern **29***p* of the circuit substrate **29** is performed, the temperature measurement member **17** and the substrate **26** can be simultaneously connected to each other. Therefore, the laser beam source module MJ**4** can be easily manufactured.

Moreover, the circuit substrate **29** is the flexible printed circuit, and thus, the flexible printed circuit can be disposed on the rear surface **26***u* side of the substrate **26** with a certain degree of freedom. For example, in the case where the mounting angle of the laser beam source LD is changed due to the optical-axis alignment or the like of the laser beam source LD, even when some misalignment occurs in the disposition of three pin terminals of the laser beam source LD on the rear surface **26***u* side of the substrate **26**, the flexible printed circuit can be disposed to match the misalignment. Accordingly, the laser beam source module MJ**4** can be more easily manufactured.

In addition, the temperature measurement member **17** is a chip type thermistor, and thus, the surface mounting of the temperature measurement member can be performed on the circuit substrate **29**. Accordingly, compared to the configuration of the related art, the laser beam source module MJ**4** and the video display device **102** can be more easily manufactured.

Moreover, the laser beam source module MJ**4** includes the heat dissipation member M**15** disposed to contact the temperature adjustment member **18**, and thus, heat dissipation from the temperature adjustment member **18** can be effectively performed. Accordingly, the temperature of the laser beam source LD can be securely adjusted with improved responsiveness via the substrate **26** having improved thermal conductivity.

In addition, the present invention is not limited to the above-described embodiments, and for example, the present invention may be modified as follows, and the modifications are also included in the technical scope of the present invention.

FIGS. **11**A and **11**B are views illustrating modifications of the embodiment of the present invention, FIG. **11**A is a bottom view of a unit CU**1** of a first modification of the first embodiment, and FIG. **11**B is a bottom view of a unit CU**2** of a third modification of the first embodiment.

First Modification

The unit CU**1** including a sealing member CF**7** shown in FIG. **11**A may be configured with respect to the unit U**1** of the first embodiment. According to the sealing member CF**7**, adverse effects to the temperature measurement member **17** due to condensation in the portion can be prevented.

Second Modification

In the first embodiment, the metal substrate is used as the substrate **16** and the circuit substrate **19** and the substrate **16** and the circuit substrate **19** are appropriately configured to be integrated with each other. However, a plate material such as aluminum or copper is used as the substrate, a printed wiring board is used as the circuit substrate, and the substrate and the circuit substrate may be separately configured.

Third Modification

In the second embodiment, the solder member is appropriately used as the thermal conduction member N**55**. However, the present invention is not limited to this, and for example, as shown in FIG. **11**B, a sheet-like thermal conduction member CN**55** may be used.

Third Modification

In the embodiments, the chip type thermistor is appropriately used as the temperature measurement member **17**. However, the present invention is not limited to this, and for example, a lead type thermistor may be also used.

Fourth Modification

In the embodiments, two kinds of laser beam sources LD (RLD and GLD) or three kinds of laser beam sources LD (RLD, GLD, and BLD) are used. However, four kinds of beam sources, to which yellow is added, may be used, and four kinds or more of beam sources may be used. At this time, the laser beam source drive unit may be provided so as to correspond to the kind of the beam source. On the other hand, one kind of beam source may be used.

Fifth Modification

In the embodiments, the can type laser beam source in which the semiconductor laser element is mounted onto the metal package is used. However, the present invention is not limited to this, and for example, a package type using synthetic resin may be used.

Sixth Modification

The embodiments are applied to a head-up display (HUD) mounted on a vehicle or a laser projector. However, the present invention is not limited to this, and the present invention may be also applied to a three-dimensional display or a head mounted display (HMD).

The present invention is not limited to the above-described embodiments and modifications, and may be appropriately modified as long as the modifications do not depart from the scope of the invention.

It should be understood by those skilled in the art that various modifications, combinations, sub-combinations and alterations may occur depending on design requirements and other factors insofar as they are within the scope of the appended claims of the equivalents thereof.

What is claimed is:

1. A video display device allowing an observer to observe video of a display image, comprising:

a laser beam source module including a laser beam source emitting a laser beam and a laser beam source drive unit that supplies power to the laser beam source; and

an image generation unit that generates a desired display image from the laser beam,

wherein the laser beam source module includes:

a substrate on which the laser beam source is placed and which has improved thermal conductivity;

a temperature measurement member that measures a temperature of the substrate;

a temperature adjustment member that contacts the substrate and adjusting the temperature of the substrate; and

a circuit substrate that electrically connects the temperature measurement member and the laser beam source,

wherein the circuit substrate is disposed on a rear surface opposite to a placement surface on which the laser beam source is placed,

wherein the temperature measurement member is mounted on the circuit substrate, and

wherein a portion of the temperature measurement member is connected to the substrate.

2. The video display device according to claim **1**,

wherein one terminal portion of a terminal of the temperature measurement member is electrically connected to the circuit substrate, and

wherein at least a portion of the temperature measurement member other than the one terminal portion contacts the substrate, and the other terminal portion of the terminal of the temperature measurement member is electrically connected to the substrate to be grounded.

3. The video display device according to claim **1**,

wherein the substrate and the circuit substrate comprises a metal substrate integrally formed of the substrate and the circuit substrate.

4. The video display device according to claim **1**,

wherein the laser beam source module includes a thermal conduction member having improved thermal conductivity, and

wherein a portion of the temperature measurement member and the substrate are connected to each other via the thermal conduction member.

5. The video display device according to claim **4**,

wherein the thermal conduction member comprises a solder member.

6. The video display device according to claim **4**,

wherein the circuit substrate comprises a flexible printed circuit.

7. The video display device according to claim **1**,

wherein the temperature measurement member comprises a chip type thermistor.

8. The video display device according to claim **1**,

wherein the laser beam source module includes a heat dissipation member disposed to contact the temperature adjustment member.

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